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ELECTRIC FEEDERS OF MAIN LINE RAILWAYS.

SAVE us from our friends is a saying which has never appeared better applied than to many would-be friends of electrical traction. That electrical energy can be transmitted through a wire many thousand times faster than steam will flow through a pipe, appears to be a sufficient basis of argument for the superiority of electrical methods over steam, and the result is a crop of inventions of the Heilmann type and others, which take no cognisance of practical facts. With regard more particularly to main line railway traffic, whatever the future may bring forth, it is a fact to-day that electrical traction could not be applied to the carrying on of the services of our trunk lines, and it is satisfactory to find so able an electrician, both theoretically and practically, as Mr. Frank T. Sprague boldly asserting this in the pages of the *Engineering Magazine* for this month. Mr. Sprague is particularly severe on the electrical prophets, who are already chanting the epitaph of the steam locomotive, having no thought to financial, geographical, or climatic conditions or established facts, and we cannot do better than recommend a perusal of Mr. Sprague's article, the final paragraph of which we quoted in our last issue. The annoying character of the claims made for electrical traction is the more to be deplored, seeing that there is a suitable, if more modest, field for its exploitation over which our too exuberant friends are flying too high to perceive its extent. We refer to the feeding of trunk lines not merely at already established points, but at numerous others. Anyone who is in the habit of travelling into the byeways of the country knows how the present feeder lines are worked. There is a train of three to five carriages and an old main line locomotive. This train runs from the junction to the little town at the end of the branch, or to some other trunk line junction, two to five times a day. It involves the payment of a driver, guard, and stoker, besides sundry others, such as stationmasters and porters, and it often runs with a couple of passengers only, sometimes possibly with none, for it must run *there*, in order that it may run *back* at the appointed hour. Excepting the few journeys per day, and Bradshaw's pages will show how very few are the trains on numerous branch lines, the locomotive is dozing in a siding and the men idle, and no better pleased than if they were at work. One may see several such trains departing from a single junction. If now, at such a junction, there was a small generating station, and in place of a four-car train there was run to and fro the day through at more frequent intervals a single light electric car on which one man could easily perform the joint offices of the three men of the steam propelled train, would not this be a great improvement both for the inhabitants of the villages served by the branch and for the shareholders in the

railway? It is so perfectly obvious that one conductor could do the work of the three men, and that, in place of a locomotive, one man at a generating station could drive the plant to serve a couple or three such branches, as well as generate electricity that would light the junction station at night, that one may well marvel that there should be so much useless and premature talk of main line electrical traction with such a lot of work ready to be carried out on a paying basis that would be easy to carry out, and at the same time would teach valuable lessons should main line work ever come within the field of practical undertakings. The too enthusiastic electrical traction prophet bases all his plans on the central idea of the man who wants to get from London to Manchester in three hours, and there conduct some great business undertaking with the celerity that characterises the hero of the three-volume novel, and get back to dine in London. Well, the steam railway is good enough for these men. The true passengers for the electrical feeder line are the score of country people with loads that are too heavy to carry to market, or they would be carried, and are now very frequently taken by road, simply because the railway only affords its three trains a day. Thus it is that to-day, when the small producer takes produce to market, he is compelled to harness his horse, and to put it up at the market town hotel. He has to pay the stable boy, pay for oats, pay for his dinner in the hotel, and when he gets home in the evening and balances up, he finds a very small cash balance as the result. It has cost him too much in incidental expenses, and so we hear that farming does not pay. If anyone wants an illustration of what we mean, let him visit such towns as Spilsby or Spalding, Newark or Sleaford, or other similar places on market day, and he will be divided between wonder as to where farmers get so much money as they may be seen to spend, and the loud grumblings as to hard times. One cannot leave Brill later than 8.25 a.m. any day for Aylesbury to attend to business, and you must stop in Aylesbury all day and not get home to Brill until 4 55 p.m. This is a condition for which perhaps the railway company cannot be blamed, but it is utterly destructive of the profits of the small producer. If these branch lines were worked electrically with light cars at a reasonable frequency, they would at once carry many times the present number of passengers, for they would secure, in addition to the present traffic, those who don't go because of the few trains and long hours of waiting, they would carry many who now must travel and do so in traps, and would take those who now walk one way.

These country people don't want high speed. It matters very little to them that a journey takes 10 minutes or 20, but they do require a better service in point of frequency, and there are hundreds of trains run daily whose duty would easily be filled by a light car of omnibus type, electrically operated, and this is work that already lies to hand to be done. We do not ridicule the light railway movement. It is plainly to be seen by anyone that we already possess a good deal of light railway; but it is being wrongly operated with heavy traffic vehicles instead of by light self-propelled cars. The heavy engines now used wear the rails and road-bed just as though there were 200 passengers in place of the two we observed the other week at a country terminus.

Why, we would ask, has the electrical railroad made such progress in America? First because there are few branch lines feeding the trunks, and secondly, the roads are bad, and the country, once only populated along the trunk railroads, is filling up more, and affording scope for feeders, and these feeders are electrically operated; the cars either stop at known points along the highways, when fairly frequent, or anywhere to suit passengers when less frequent, and are helpers, not competitors, of the main lines. It is pitiful to listen to the arguments in favour of high speed electrical traction, when the steam locomotive is at present perfectly competent to deal with speeds as high as the permanent way will bear; nor have we yet any proof that very high speeds are to be operated safely unless with a heavy leading vehicle like the steam locomotive. But the question of electrical traction certainly seems to be solving itself on the lines of motor cars, as at Liverpool, rather than of electrical locomotives, as on the City and South London line, and very high speeds are really not needed on the service of which this country stands so much in need.

While American experience is valuable to us, it will not do to be too much guided by it. Many of the electrical lines there run practically parallel with the steam lines, and have taken away a good deal of the traffic of these lines. This aspect of electrical work has been considered by Dr. Duncan in his inaugural address at Niagara Falls to the American Institute of Electrical Engineers, and he points out there is quite a strong tendency towards the conduct of even through traffic by electricity, and he concludes that economical passenger traffic has tended in the direction of greatest economy for electrical working, whereas freight traffic has gone the opposite way, and is best worked by long and heavy trains; and he says:—(*a*) It will not pay any through line having considerable traffic to equip its main line electrically. (*b*) It will pay a four-track road to put in electrical equipment on all tracks, unless a considerable portion of traffic is through passenger traffic (*c*) It will pay all larger roads to equip a number of their branch lines electrically, or to control competing electric lines.

Dr. Duncan believes that, as ultimately all traffic will be conducted electrically, wherein he is not in agreement with Mr. Sprague, whom, however, we incline to look upon as the safer guide, it is imperative that railway managers should keep in touch with electrical progress, and on this last item we are quite in agreement with him. His conclusion (*c*)—at least the first half thereof—represents, practically, the conclusions to which our own study of the problem in this country has led us, the second part, referring to competing lines, not being yet applicable, and not likely to be so for some time to come, for the good reason that English railways have not to a very large extent been made parallel with the common roads which would now serve to accommodate competing electrical tracks. Taking all things into account, it, therefore, appears that the extension of electrical working has its most hopeful direction in the branch railways of this country. The railways are there, so are the passengers and a light goods traffic only waiting to be developed, and the cost to be incurred is merely the equipment, which need not be specially onerous, or involve the use of a plant that could not easily be removed intact, should the experiment not

be successful. But we do not fear this; everything is in favour of the new system, and if the railway companies neglect to take the matter up, they will be simply deprived of what little traffic they now have, and will require to stand by and see the bye-ways served by electrical tramways, or by gasolene motors, such as are attracting so much attention in France. Just so much as the self-contained steam locomotive is suitable, on the one hand, for long-distance express traffic or slow-speed heavy goods traffic, is it unfitted for the service we have in mind, and it is just in this service that an electrical system finds its best field. The gauge of all the branch lines being standard, there is no reason why, when a special occasion demands it, the ordinary vehicles from the main line should not be run upon the lines and hauled by the motor cars, which would always comfortably haul three times their own weight behind them at moderate speeds. Indeed, this question of working branch lines electrically presents no really serious difficulties. We would commend it to the attention of electrical men, who should also read what Mr. Sprague has written on the matter, as this is, subject to the different conditions here and in America, quite a treatise on the question, and as markedly practical as is another article in this same July number, by Mr. Julien A. Hall, impractical and valueless, entirely overlooking as it does the business aspect of railroading.

Even the objections raised by some people to the trolley system and overhead wire lose all their force when it is a question of applying the trolley system to a fenced-in English branch railway. Everything points to the desirableness of the change we advocate. There is nothing heroic or startling in the work to be done. It is a simple humdrum work, but there is plenty of it to be done, and it means business.

The Direct Spanish Telegraph Company *versus* Owners of the ss. *Caloric*.

THE appeal of the plaintiff company against the decision of Mr. Justice Day, was heard on the 14th inst., and was dismissed. We gave a notice of the case on March 29th, under the heading of "The Responsibilities of Submarine Cable Companies," drawing attention to the fact that the Direct Spanish Telegraph Company had, for some reason best known to themselves, neglected to publish information as to the position of their cables in Bilbao Bay. Another point seriously against them was their contention that their cable had been cut with an axe, in support of which no evidence was offered. Now nothing, to our mind, should be easier to prove than whether or not a cable has been hacked with an axe, and such a statement should, therefore, never have been made. On these two important points, then, the Direct Spanish Telegraph Company were entirely wrong, but their action was brought on the grounds that the damage done to their cable was due to the negligence and want of care and skill on the part of the crew of the *Caloric*. First comes the admission that, though there was a spare anchor on board, there was no standing tackle with which to get it out. Then follows the ludicrous picture of a ship riding by two telegraph cables, which must necessarily be leading well out ahead as the ship was held (there is no mention of the anchor surging along), and the captain afraid to move the engines lest the propeller should foul them; and this, even although his ship was stern on to a lee shore, and began to drift as soon as the larger cable, belonging to the Direct Spanish Telegraph Company, gave way. The position in which the captain of the *Caloric* found himself was not one of any difficulty, and to have taken no steps to clear the cable, beyond trying to catch it with a hook which was too small, shows if not want of skill and care, something approaching downright indifference. There was no need to abandon the anchor, and the contention that this should have been done was a wrong one. But it certainly should have occurred to both the captain and the chief officer that the right way to free the anchor was to pass the end of a rope under the cables, and by paying out chain allow the anchor to fall clear, the cable being supported by the rope which could afterwards be either cut or let go. But no; the easiest way seemed to be to cut the cables, and the carpenter was therefore lowered over the bow with an axe, and in 25 minutes he succeeded in hacking the smaller cable in two, and by that time, the larger one having chafed and broken, the *Caloric* was clear. Whether or not the cable could have been entirely saved from damage is another question. Probably it was damaged before it was known that it was hooked, though presumably this did not occur until the anchor was hove in, or it would never have dragged with 75 fathoms of chain out. The failure of the Direct Spanish Telegraph Company to win their case is a very serious matter, not only to themselves, but to all who are connected with submarine telegraphy. If they had limited themselves to the contention that there was negligence and want of skill, and brought out all their strength in support of it, we think they might have succeeded.

Steam Engine Trials.

Engineering sounds a note of warning regarding engine testing, specially with regard to brake inaccuracy. Perhaps the rope brake is the best of the simple brakes that can be devised, but even the rope brake is sometimes made to show incorrect results, and we believe the circumference of revolution is sometimes taken as the external surface of the rim on which the rope bears in place of being measured at the middle of the rope thickness. Our contemporary urges the large English engine builders to follow the example of the Sulzers and of American builders and show of what they are really capable, and quotes Mr. Longridge as saying what difficulty he has found in getting engines prepared for thorough testing. We are by no means certain that the great Lancashire firms of whom our contemporary speaks are sufficiently alive to the importance of certain refinements to follow the lead of the Swiss engineers for example, but there is absolutely no reason why they should not at once place themselves in line with the most economical practice. In the best American record, that of the Milwaukee pumping engine, a prominent feature was the smallness of the clearance volumes, and another prominent feature was the slowness of the speed. This latter feature, usually not allowed to be conducive to economy, does not appear to have had any bad effect, while the small clearance appears to be the reason or a reason for the small steam consumption. A triple expansion engine of Lancashire make is named, having clearances three to five-fold that of the respective cylinders in the Milwaukee engine. But, in all future engine tests, we think that besides the clearance volumes, the initially exposed internal areas should be given, and also the quality of such surfaces, whether plain cast, turned, polished or plated. It seems to us absurd to spend time and money over tests from which are excluded some of the chief data, while mathematical discussions of the thermo-dynamics of the steam engine seem out of place. Surely no one now doubts the limitations placed upon attainable efficiencies, whereas we still have doubters among us who entirely refuse to credit the effects usually associated under the general term of cylinder condensation.

RESEARCHES ON THERMO-ELECTRICS.

When Prof. Dewar succeeded in perfecting his now classical apparatus for producing exceedingly low temperatures, we anticipated that it would never remain a mere scientific curiosity, but would, in the hands of the professor, very soon be put to practical application. Our anticipations have been fully justified. Prof. Dewar has already in the comparatively short time which has elapsed since his first epoch-making lecture on low temperatures, enriched our knowledge with discoveries which, but for him, would probably have been delayed for years; and it is clear that the researches which he has so far carried out are but an earnest of those which are to follow.

Recently Prof. Dewar has been collaborating with Prof. Fleming in an investigation, the object of which has been to throw some new light upon the thermo-electric powers of metals and alloys at temperatures between the boiling point of water and that of liquid air. Their results are to be found in the *Philosophical Magazine*; but the authors have kindly favoured us with a reprint.

We owe most of our knowledge up to the publication of this paper to Prof. Tait and Lord Kelvin. It was the latter's researches on thermo-dynamics which suggested to Prof. Tait the starting point for that work, the outcome of which was to show that on certain assumptions the curves representing thermo-electric power plotted as a function of temperature should be straight lines, and consequently that the lines of thermo-electromotive force obtained by plotting as ordinates the E.M.F. in a thermo-electric circuit, one junction of which is kept at a constant temperature, whilst the temperature of the other is varied, should be parabolas with their axes vertical if plotted in terms of the variable temperature as abscissæ; but Prof. Tait's deductions were based upon experiments within the limits of the temperatures which can be reached by mercury thermometers and certain temperatures above that range. Nevertheless, these experiments confirmed Prof. Tait's conjectures for a large number of thermo-couples, although they led to the remarkable discovery that the thermo-electric lines of certain metals, notably of the magnetic ores, are for temperatures above 0° C., broken lines characterised by sudden changes of direction.

It has been the business of Profs. Dewar and Fleming to carry out experiments during which the temperature was lowered to — 200° C. by the employment of boiling liquid air and oxygen. The data thus gathered have enabled them to continue the well-known thermo-electric diagram of Prof. Tait down to temperatures not very far removed from the absolute zero. This diagram, which, by the way, enables the temperature of inversion to be determined by inspection, may now be said to exhibit more elegantly and completely than ever the chief thermo-electric facts.

The metals used were for the most part in the form of wires. From these a large quantity of thermo-electric couples were prepared, each consisting of two wires of lead joined by an intermediate wire of one of the following metals, viz.: platinum, gold, palladium, silver, copper, zinc, cadmium, magnesium, tin, iron, nickel, pianoforte steel wire, Hadfield's manganese steel (non-magnetic and magnetic) manganin, German silver, platinoid, bismuth (pure and commercial) antimony and aluminium; a carbon filament from an incandescent lamp was also coupled with lead.

The chief experimental difficulty encountered was that of determining the low temperature and the instant when the E.M.F. of the couple was made. Needless to say, this was after long preliminary investigation solved and the apparatus finally used was based upon the employment of a platinum thermometer for measuring the temperature, and a measuring instrument which could be changed instantly from a potentiometer into a resistance balance. This involved an expenditure of ingenuity such as invariably characterises the apparatus with which Prof. Dewar conducts his researches. His account of the expedients to which he found it necessary to resort is well worthy of careful study by those who are young at experimental investigation.

The laborious work entailed by taking and reducing the observations recorded, as well as by the construction of some of the apparatus, was largely assisted in by Messrs. Morris and Jakeman. In the case of each couple a series of numbers for each metal representing at defined temperatures the thermo-electromotive force of that metal against lead was obtained; and all these observations were reduced to a statement of the E.M.F. in C.G.S. units of a couple formed of a given metal and of chemically pure lead, one junction being at 0° C. and the other being at a platinum temperature, $p\ t$, as defined by the standard platinum thermometer. The corrected results are graphically shown plotted down in a chart in the original paper. The lines of thermo-electric force thus found are in all cases curved. Wherever the curve has a maximum point so that its tangent becomes parallel to the line taken at the axis of temperature, the temperature at which this occurs is the neutral point of that metal with regard to lead. If, at any temperature, the tangents of the curves of two metals are parallel to one another that temperature is the neutral point of these two metals with regard to each other, or is the temperature of inversion.

The diagram of thermo-electric powers can be at once obtained from that of the thermo-electric force by drawing a series of lines, the ordinates of which represent to proper scale the *slope* of the curves of thermo-electric force.

The chief interest attaching to these investigations is obviously the ability to determine whether, over wide limits of low temperature, the thermo-electric lines of various metals remain straight lines, and whether any of the metals exhibit changes of thermo-electric power at low temperatures which cause thin thermo-electric lines to be bent or broken, thus indicating a sudden change in the sign or magnitude of the "Thomson effect" at certain temperatures. The chart which has been constructed by Profs. Dewar and Fleming is capable of giving all the information that can be required, and thus of providing the data necessary for a full discussion of the subject. They, however, reserve a discussion of the interpretation of these thermo-electric curves, and the bearing of the facts they disclose on the usually accepted thermo-electric theory for a future paper. Meanwhile we are glad to notice that they propose to convert the chart of electromotive forces into a chart of thermo-electric powers, in which condition it will lend itself better to a discussion of results. We shall await the publication of it with special interest.

ARMATURE CROSS TURNS IN CONTINUOUS CURRENT DYNAMOS, AND THEIR EFFECTS.

By GEORGE ADAMS.

(Concluded from page 37.)

To determine the effect of the copper shell on the induction in the air gap, we may suppose the surface of the armature and pole piece to be straightened out into a plane as in fig. 5, where A A represents the surface of the armature,

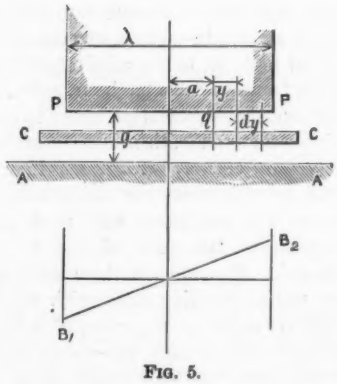


Fig. 5.

P P that of the pole piece, and $c\ c$ the current shell. Selecting any point, q, on the pole face at a distance, a, from the centre, we find the induction within the air space at q is due to the action of all the current elements to the right and left of that point. This integration being extended to the

edges of the polar face. A current element, $\gamma\, d\, y$, at a distance y from q, produces a magnetising force

$$H = \frac{\cdot 4\ \pi\ \gamma\ d\ y}{2\ g},$$

where g = length of air gap.

This formula is derived from the general formula $H = \frac{\cdot 4\ \pi\ c\ r}{\frac{l}{\mu}}$, where l = length of magnetic circuit.

μ = permeability.
r = number of turns.
c = current in each.

Integrating over all the elements to the right of q, we have the induction through q due to that part of the current shell which lies to the right of q. Neglecting the very small magnetic resistance of the iron part of the path of lines, this induction is

$$\int_0^{\frac{\lambda}{2} - a} \frac{\cdot 4\ \pi\ c\ r}{2\ g}\, d\, y = \frac{\cdot 4\ \pi\ c\ r}{2\ g}\left(\frac{\lambda}{2} - a\right).$$

In a similar manner we find the induction due to that part of the current shell which lies to the left of q.

Or
$$\int_0^{\frac{\lambda}{2} + a} \frac{\cdot 4\ \pi\ \gamma}{2\ g}\, d\, y = \frac{\cdot 4\ \pi\ \gamma}{2\ g}\left(\frac{\lambda}{2} + a\right),$$

this is of opposite sign, and the resultant induction is the algebraical sum of these two values, namely—

$$\frac{\cdot 4\ \pi\ \gamma}{2\ g}\left(\frac{\lambda}{2} - a\right) - \frac{\cdot 4\ \pi\ \gamma}{2\ g}\left(\frac{\lambda}{2} + a\right) = \frac{\cdot 4\ \pi\ \gamma}{2\ g}\ 2\ a.$$

For $a = o$, that is, for the centre of the pole piece, the induction is zero. For $a = \frac{\lambda}{2}$, that is at the edges of the pole piece, it is a maximum, being posiitve for one and negative for the other edge, as shown by the sloping line, $B_1\ B_2$.

The maximum value is $\frac{\cdot 4\ \pi\ \gamma\ \lambda}{2\ g}$, and since $\gamma = \frac{r\ c}{\pi\ d}$ we have the maximum induction,

$$= \frac{1{\cdot}257\ \lambda}{2\ g}\ .\ \frac{r\ c}{\pi\ d}.$$

Fig. 6 is a diagram of the pole pieces of a dynamo. If radial lines be drawn from the centre, o, to the surface of the

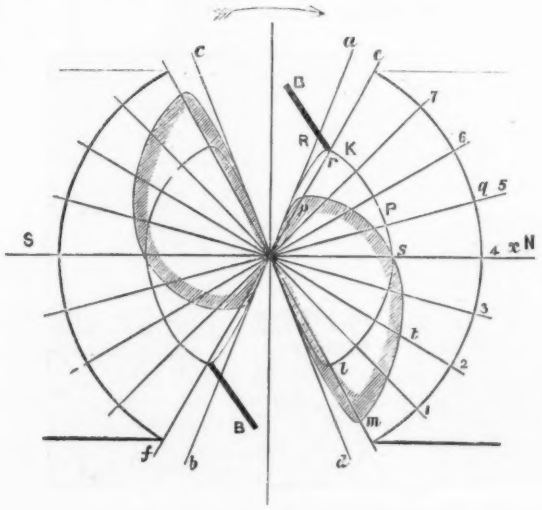


Fig. 6.

pole pieces, the radial lines being at equal distances apart, say every 20°, we may take a distance on any of the radial lines from the centre outwards, such as o, p, to represent the induction in the air gap due to the direct ampère turns of the field magnet. Since the induction due to the ampère turns of the field magnets alone may be considered uniform all over the polar area, we may draw an arc of a circle with the radius, o, p, to represent this induction, and the intercepts between the centre, o, and the arc, p, will give the magnitude of the induction due to the ampère turns of the field magnet. The fringe at the pole tips must be added to the length of the polar arc. The fringe is usually taken as equal to half the length of the air gap to be added to each pole tip. The fringe is represented by a, e, in fig. 6. Thus, if we take a vector revolving about o, in the anti-clockwise direction; starting from the line, o, x, we arrive at the line, $o\ e$, coincident with the pole tip. The influence of the pole piece begins to weaken at this point, and if we continue the rotation of the vector, it will be seen that the influence of the pole piece rapidly falls off until zero induction is reached at o, a. We have now to consider the effect of the armature cross turns. If we suppose the armature to revolve in the direction of the arrow in fig. 6; from what has been said the induction at the leading polar tips, e and f, will be weakened by the action of the cross turns, while at the trailing tips, c and d, the induction will be strengthened. The maximum induction due to the cross turns was found to be

$$B = \frac{1{\cdot}257}{2\ g}\ .\ \frac{r\ c}{\pi\ d}.$$

Set off this distance on the line, o, e, from the circle, p, inwards, and on the line, c, d, from the circle, p, outwards; we thus find two points on the curve representing the resultant induction in the polar gap. The curve also passes through the point, s, corresponding to the point of zero induction when the armature cross turns are alone considered. The curve passing through these points will be an Archimedean spiral, the equation of which, in polar co-ordinates, is $r = a\ \theta$.

r being the radius vector.

θ = the angle included between the radius vector and the line, o, x.

a is a constant dependent upon the number of radial lines used.

The curve may be found graphically thus:—Draw a line to represent to scale the polar arc straightened out (fig. 7). Bisect this line at c, and set off on the vertical a distance

$$A\ D = B_x = \frac{1{\cdot}257\ r\ c\ \lambda}{2\ g\ \pi\ d}.$$

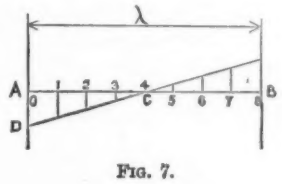


Fig. 7.

Divide the line, A, B, into as many equal parts as the polar arc in fig. 6, and number them to correspond. Erect ordinates at each division in fig. 7, and set off these ordinates on the corresponding radii in fig. 6, above or below the circle, p. Draw a curve through the points thus found. The radii vectors of this curve will give us the resultant induction in the air gap. Thus, at the position, o, 2, the resultant induction will be represented by the length, o, t. Beyond the lines, o, e, and o, d, the curve falls rapidly to zero.

If the circle, p, be taken to represent the commutator, the brushes, B, B, must be placed somewhere on the arc, R, v, for sparkless collection.

In modern practice it is not usual to allow less than 2,000 lines per square centimetre as the induction at the leading pole types. This would be represented by the length, o, h, in fig. 6.

If the armature cross ampère turns are large compared with the ampère turns of the field magnet, we may obtain a curve which has a negative loop, as shown in fig. 8. In this case sparkless collection will be almost impossible. In order that collection may be sparkless, the ampère turns of the field magnets required to overcome the resistance of the air gap must be greater than the cross ampère turns of the

armature. Calling the latter $c_x \tau_x$, and ampère turns required to overcome resistance of air gap $c_a \tau_a$

$$c_x \tau_x < c_a \tau_a$$

$$c_a \tau_a = \cdot 8 \times 2 g B_a \text{ where } B_a = \text{induction in air gap}$$

$$c_x \tau_x = \frac{\tau c}{\pi d} \cdot \lambda.$$

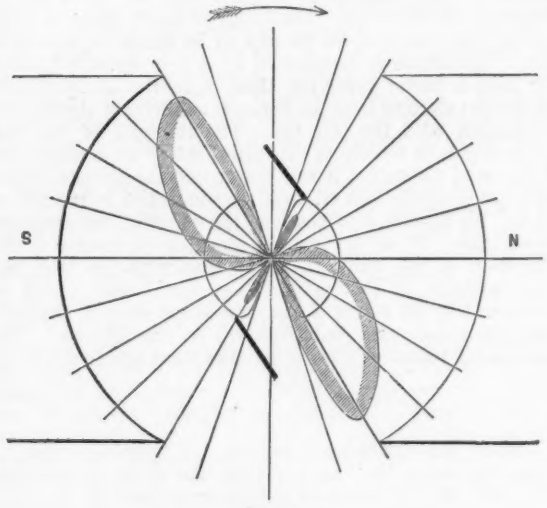


Fig. 8.

The induction under the leading polar edge is

$$B_a' = \frac{1{\cdot}256\ (c_a \tau_a - c_x \tau_x)}{2 g}.$$

and under the trailing polar edge

$$B_a'' \frac{1{\cdot}256\ (c_a \tau_a - c_x \tau_x)}{2 g}.$$

The induction under the leading and trailing polar edges are expressed in terms of the average induction as follows:—

$$B_a' = B_a \frac{(c_a \tau_a - c_x \tau_x)}{c_a \tau_a}$$

$$B_a'' = B_a \frac{(c_a \tau_a + c_x \tau_x)}{c_a \tau_a}.$$

ELECTRIC TRACTION ON BRANCH LINES.

Amid the discussion that is taking place upon the applicability of electricity to steam railroads, it is interesting to mention an instance where electric traction has been utilised on a branch line of a railway. Details are very scanty but we learn sufficient from the columns of the *Electrical Review* of New York, to show that a real and practical attempt has been made to carry electric traction a step farther.

The line on which electricity is being tried to meet all the conditions of ordinary railway practice is the Nantasket Beach branch of the Old Colony Railroad Company, Massachusetts. The line is seven miles in length and has many sharp curves and heavy grades. An idea of what the line offers in these two respects may be gathered from the fact that of the total length of seven miles, 4·4 miles is curve.

The road is double track throughout its entire length. The rails are of the regular "T" type, 4½ inches high and weighing 78 pounds to the yard. They are laid 15 feet apart from centre to centre, and heavily ballasted.

The poles supporting the feed wires and trolley cross arms are set between the tracks (see illustration). They are placed from 60 to 90 feet apart, the shortest distances being on the curves. Each pole is surmounted by an iron cap grooved in the top to receive the feed wires, which are six in number, and laid side by side. These feeders are of bare stranded copper wire of 500,000 circular mils each.

The cross arms supporting the trolley wires are composed of two 2 × 3 inch iron angles bolted across the post, one on each side, and bent and securely fastened at the ends. The trolley wire itself is also of novel construction, being somewhat in the shape of a figure 8. The lower part is somewhat larger than the upper, and the clip from the cross arm fits securely around the upper section, leaving a smooth and unbroken surface for the contact of the trolley wheel. The trolley wire is of 433,000 circular mils.

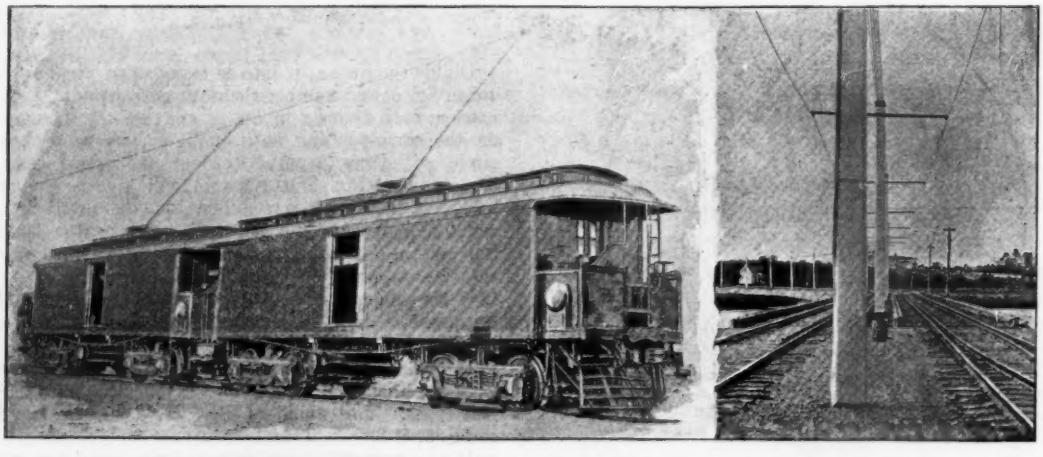
The heavy motor cars, which are particularly intended for express service, are in the form of combination baggage cars, as will be seen from the accompanying illustration, and will draw a train of the ordinary size.

They are equipped with from two to four motors each of the General Electric 2,000 type. They are built extra heavy to secure tractive power, weighing about 60,000 pounds, and have a draw-bar pull of 4,000 and 8,000 pounds.

Current is furnished from the power house at a pressure of 700 volts by two generators of 1,500 horse-power each, direct connected to two tandem compound Green-Corliss engines. The expense of the equipment has been very heavy, but, apart from the importance of the project from an experimental point of view, it will doubtless, says our contemporary, prove a well-paying investment.

Trains will run on a frequent schedule and preparations have been made for handling immense crowds of transient visitors. The novelty of the thing, together with the five-cent fares which will go into operation with the opening of the line, will draw big crowds, especially as the road runs through a picturesque section, and, for the greater part of its length, directly along the shore.

The road was formally opened to the public on Sunday, June 30th. Previously a trial trip for the benefit of the officers of the road was made, and the entire success of the installation thoroughly demonstrated.



Combination Electric Motor and Baggage Car for Express Service. View of Track.

This run was made at night, the party comprising only officials, and the idea being to give a test of speed.

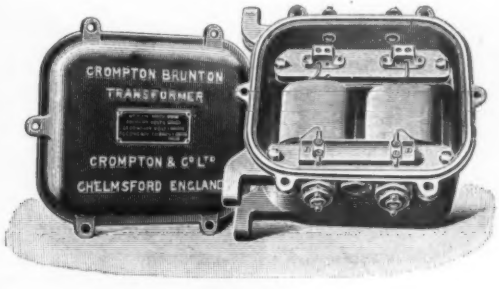
It was *estimated* that a portion of the run was made at a speed of 80 miles an hour, and a hot box was the only thing

which prevented a still higher figure, as, when the current was turned off, there were still five notches to spare on the controller, and the momentum acquired carried the car two miles further at a speed of nearly 50 miles an hour.

On June 25th, another test of the equipment was made with the object of showing its capacity for hauling freight. A motor car successfully pushed and hauled 16 freight cars containing between 450 and 500 tons of freight at a speed of 25 miles an hour. From the standpoint of practical railroading, this test was of far greater value than the speed test mentioned above. The motor car handled this load without effort and its limit of capacity was not reached. The trial satisfied the officers of the road that the electrical equipment was alike practical for passenger and freight service.

NOTES ON CROMPTON'S ALTERNATING CURRENT WORK.

Crompton & Co.'s alternate current work may be said to date from 1889, when the Chelmsford electric lighting station was started, with alternators of 75 kilowatts.

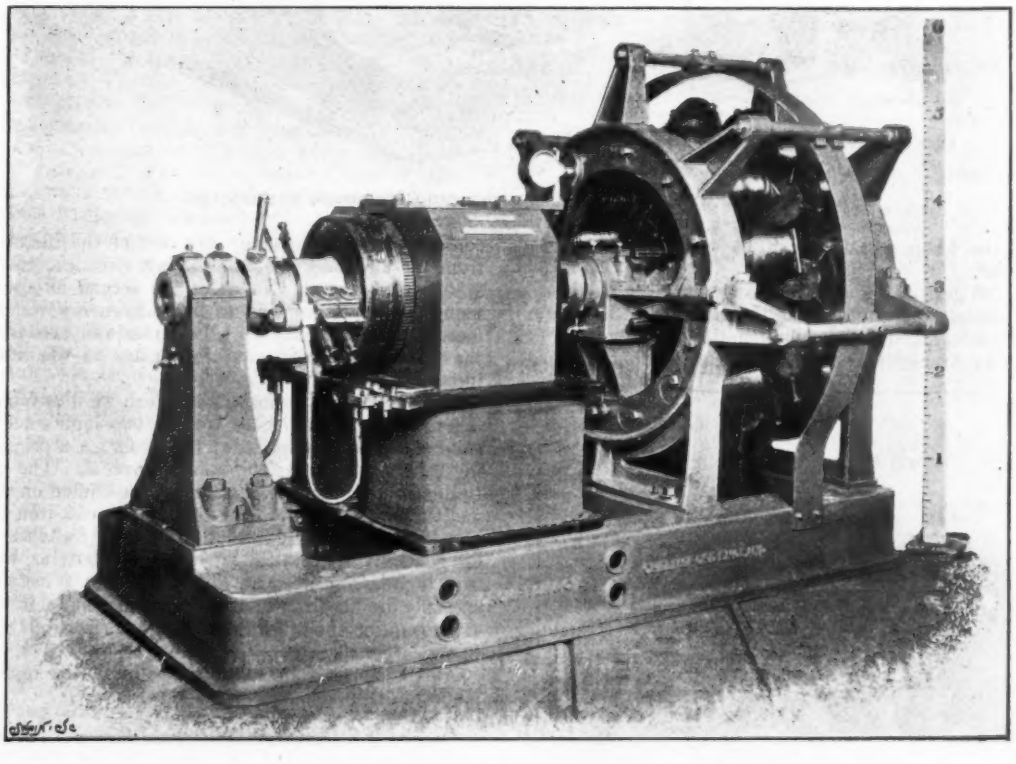


The lighting at the Barry Docks was carried out by them in the succeeding year.

In 1891 a small station was equipped at Chagford, the motive power being water.

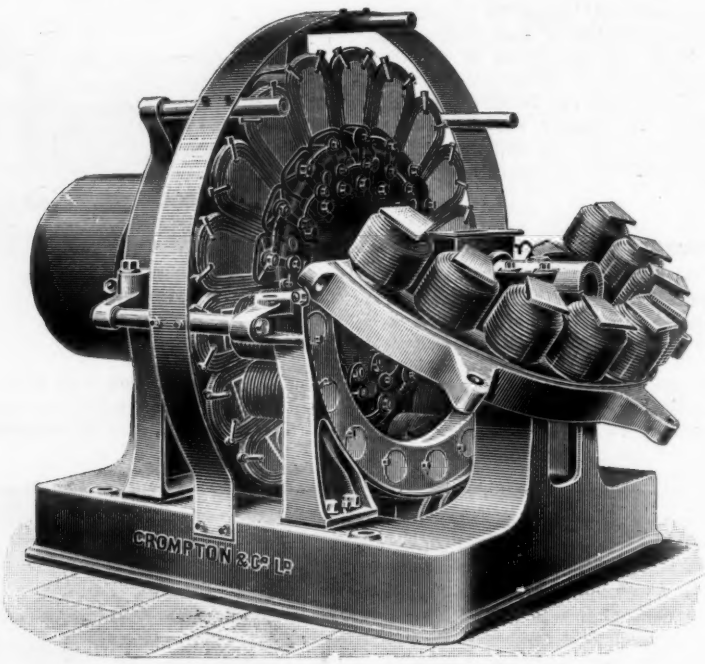
In 1891 Messrs. Crompton & Co. commenced building transformers as a regular branch of manufacture, and the sales have steadily increased from that time, the increase being specially marked during the last two years. All sizes, up to 40 kw., have been manufactured, and at various voltages, up to 6,000.

In 1891, Messrs Crompton & Co. also commenced building alternators, working, first, at a type having an iron-cored stationary armature, and bearing a close resemblance to one lately put on the market by a well known firm. For various reasons this, though partially successful, was discarded in favour of the present type, as being the most suitable all-round pattern, giving the highest efficiency, working with least noise, and using a minimum of material in its construction. At the same time, with alternators, as with lighting systems, no one type or system can be considered as always the best for every condition, and for special conditions, such as an extra high E.M.F. or very low ~, Crompton & Co. would, no doubt, build a different class of alternator (*e.g.*, in a 250-kilowatt alternator which they have recently constructed for a very low ~ and low E.M.F., the armature has a cylindrical iron core and winding somewhat resembling an ordinary drum winding). Several hundred kilowatts of these alternators have already been manufactured and are at work, and some 400 kilowatts are in hand at the present time in various sizes from 5 to 200 kilowatts. The present type of alternator, of which the manufacture was regularly commenced in 1892, is on the well-known lines of the old Siemens alternator of 1878, resembling in this respect the present Siemens and Ferranti machines, from which it differs, however, in many constructional details. A special feature is the method of supporting and tightening up the armature coils. Each coil is held by a wrought delta metal bolt between two strong bronze brackets, which secure it to the hub keyed to the shaft, and by means of an eccentric bolt, can be moved in or out radially. By drawing all the coils in together, they are very tightly compressed one against



Crompton-Brunton Alternator with Direct-Coupled Exciter.

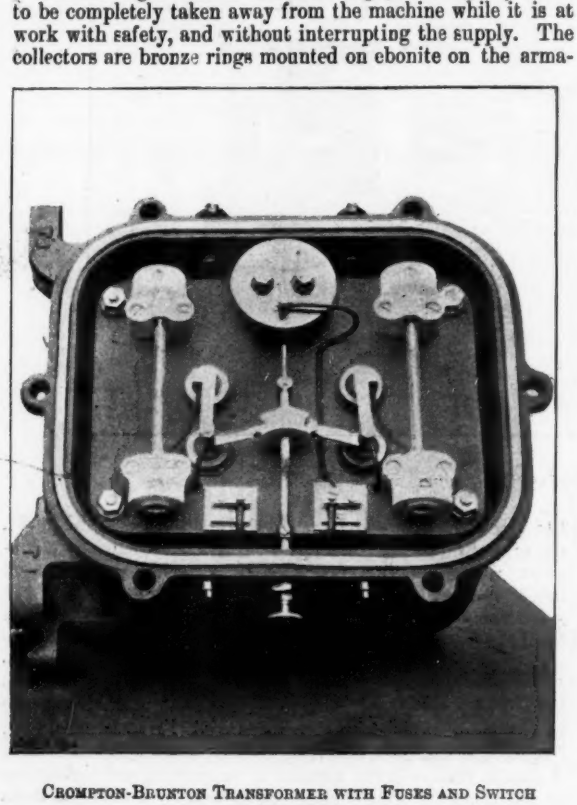
another, making a very rigid armature and doing away with all possible chance of detrimental vibration of the conductors and destruction of the insulating material; moreover, a coil can be taken out and replaced with great ease. Another feature is the hinging of the field magnets,



Alternator with Half of Field Opened to Give Access to Armature.

whereby the whole armature can be easily inspected (see illustration).

The brush gear also is of novel design, enabling any brush to be completely taken away from the machine while it is at work with safety, and without interrupting the supply. The collectors are bronze rings mounted on ebonite on the arma-



Crompton-Brunton Transformer with Fuses and Switch in Position.

ture hub, and one each side of the armature. As illustrating the good efficiency of these alternators, we may say that a pair of 37½ kw. each, 550 revolutions, constructed as motor alternators (*i.e.*, a continuous current motor coupled direct to an alternator on the same bedplate) for Sunderland Corporation to Prof. Kennedy's specification, gave a through efficiency of 84½ per cent., including the field excitation for both motor and alternator. The method of test was to put in continuous electrical energy into one of the motors, take it from one alternator as "alternating electrical energy" (at 2,500 volts), use this to drive the second alternator as a motor, and obtain continuous electrical energy from the other motor used as a dynamo. All the measurements from which the efficiency was calculated were taken on the same set of instruments.

In the Crompton transformer, which we illustrate, the core is a rectangular iron link. On the two long sides the two coils of winding are placed. Each coil has a primary winding below, and a secondary winding over it. The insulation is almost all mica. The terminals are mounted on stoneware, and the whole is enclosed in a watertight cast-iron case, with glands with stoneware insulating bushes. Switches and fuses are generally fitted in the same cast-iron box, as well as an earthing device or earth shield. These transformers are specially designed for a small drop and small circuit loss—1 per cent. of the full load in medium size, and below this in the larger sizes.

All transformers are submitted to insulation tests of from 5,000 to 6,000 volts.

TESTS OF A COMBINED ELECTRIC LIGHT AND ELECTRIC RAILWAY CENTRAL STATION.*

By DUGALD C. JACKSON and ARTHUR W. RICHTER.

(*Concluded from page* 55.)

Tests.

The coal was weighed as it was brought into the boiler-room. The water-level and steam gauges were kept as nearly constant as practicable, and at the close of the test the water in the Stirling boiler was at the original level, while in one of the return tubular boilers it was 1·5 inch above the string, and in the other a little over an inch below it, so they were considered as practically at the same level. The Stirling boiler was in use

* Presented at the Detroit meeting (June 28th, 1895) of the American Society of Mechanical Engineers, and forming part of Volume xvi. of the *Transactions*.

during the entire run, and at 4.45 p.m. and at 5.45 p.m. the two tubular boilers were successively cut in and were shut off again and the fires banked at 12.35 a.m. The coal used in getting these boilers up to pressure (nearly 500 lbs.) was not counted as part of the coal consumption in the computed results.

Calorimeter tests of the steam were made every hour at the boilers, and as frequently as possible at the engines, while in service. Throttling calorimeters were used, except at the railway engine, during the daytime, where there was so much water present that the throttling calorimeter could not be used, and a separating calorimeter was resorted to. The poor quality of the steam at the engines was due to the arrangement and condition of the steam mains. Engine No. 2 received the drain of the greater portion of the system. The steam pipe was connected to the under side of the main and was uncovered at the time of the test. The pipe leading to engine No. 3 was also uncovered, and as the pipe is of considerable length the condensation is considerable, while the valve provided to cut the steam from that pipe during the period when the engine is idle was not made use of. The pipe leading to engine No 1 was covered, but no provision was made to cut the steam from that pipe when the engine was not running.

The water was measured by means of two tanks placed on scales. Both feed-pumps were put into use, one as an auxiliary, to pump the water from the hot well into the tanks, and the other to feed the boilers. The latter pump communicated with the tanks by two branches of piping connected by a three-way cock, and a hose was attached to the other pump, so that one of the tanks was filled while the other was being emptied. The exhaust pipe of the regular feed-pump was connected to the vacuum of the condenser, and the steam consumption was figured from cards taken at frequent intervals, the number of strokes being recorded on a continuous recorder. The steam consumption of the auxiliary pump was ascertained by running the exhaust into a small surface condenser furnished from the university laboratory, by which means the condensed water was collected and allowance made therefor.

The railway engine, No. 2, was started at 6 a.m. and continued running until 11.10 p.m. During the day, from 6 a.m. until 6.30 p.m., this engine, besides driving the two railway generators, drove the main shaft, to which a Westinghouse alternator was belted, supplying the day demand on the incandescent circuit. This engine was indicated every five minutes, indicators made by Dreyer, Rosenkranz and Droop, of Hanover, Germany, being used on the low-pressure cylinder, and Tabor indicators on the high-pressure cylinder. These indicators were supplied with electro-magnetic devices for taking the four cards simultaneously on closing a switch, the current being supplied from storage cells. Friction cards were taken upon starting up with the generator fields excited and again with the field circuit broken. The speed was obtained by means of a continuous revolution counter. Two ampèremeters, through which the current supplying the railway feeders passed, one ampèremeter on the power circuit, and a voltmeter giving the dynamo pressures, were read every half minute. The condenser pumps were indicated at half-hour intervals and the speeds were taken.

At 6.10 p.m. the arc light engine, No. 1, was started and continued running until 5.30 a.m. At the same time the direct connected engine, No. 3, was set running, and the supply for the incandescent circuit was changed from the Westinghouse machine to the "Monocyclic" alternator. The railway engine, No. 2, now no longer drove the main shaft, but the belt ran over a loose pulley on the shaft. The arc light engine, No. 1, was indicated every 15 minutes, and the direct-connected, No. 3, every ten minutes, and the speed obtained from continuous revolution counters. Friction cards were taken both before and after the run. The current of the arc machines was measured by a Weston ampèremeter, and the voltage was obtained by a Weston voltmeter in series with a high resistance, the apparatus being placed as far from the machines as possible to avoid any disturbance which might be caused by stray magnetism. Ampèremeter and voltmeter readings for the Westinghouse alternator were taken every 15 minutes, and the "Monocyclic" output was taken by five-minute readings. The power factor of the load on each of the machines was ascertained by means of a station wattmeter, loaned by the General Electric Company.

There can be no question in regard to the reliability of the results averaged from readings taken as often as was done in this test, except in the case of the railway machinery. It is still an open question as to the best method of determining the average power developed by an electric railway engine; but the results of considerable experience with electric railways on the part of one of the authors makes us feel certain that results are obtainable by the arrangements which were used in this test, which are as accurate as those obtainable by any method yet set forth.

RESULTS OF TEST.

Boiler efficiency.

Quality of steam.
Stirling, 6 a.m. to 6 p.m., 99·2 per cent.
6 p.m. to 5.30 a.m., 99·7 per cent.
Return tubular boiler No. 1, 4.45 p.m. to 12.30 a.m., 97·3 per cent.
No. 2, 5.45 p.m. to 12.30 a.m., 98·5 per cent.
Total average, 98·8 per cent.
Average pressures:
Steam, 89·5.
Barometer, 29 inches.
Draught (inches of water), ·3
Average temperatures:
External air, 46·2° Fahr.
Boiler room, 58·9° Fahr.
Escaping gases, 422° Fahr.
Temperature of hot well, 82·24° Fahr.
Temperature of feed-water, 123·5° Fahr.
Factor of evaporation, 1·119.
Water pumped into boilers, 102,349 pounds.
Equivalent evaporation from and at 212°, 114,508
Total amount of coal burned, 17,103 pounds.
Total ash, 1,871 pounds.
Total combustible, 15,232 pounds.
Per cent. ash, 10·9 per cent.
Water evaporated per pound of coal, 5·98 pounds.
Water evaporated per pound of combustible, 6·72 pounds.
Equivalent evaporation from and at 212°, per pound of coal, 6·69 pounds.
Equivalent evaporation from and at 212°, per pound of combustible, 7·52 pounds.
Steam used in throttling calorimeters, 385·7 pounds.
Steam used in separating calorimeter, 35·07 pounds.
Total, 420·8 pounds.
Steam used by feed pumps, as figured from indicator cards, from 6.0 a.m. to 6.0 p.m., 538·5 pounds. From 6.0 p.m. to 5.30 a.m., 472·3 pounds.
Total, 1,010·8 pounds.
Steam used by auxiliary pump, 449 pounds.
Steam to be charged to engines, 100,469 pounds.

Engine efficiency.

No. 2, railway engine. 6.0 a.m. to 6.0 p.m.
Average I.H.P., 117·5.
H.P. hours, 1,410.
Average watts output, 69,200, equals 92·8 E.H.P.
Watt hours, 830,387.
Average E.H.P. divided by average I.H.P. equals 78·9 per cent.
Coal consumed in 12 hours, 7,550 pounds.
Per cent. ash, 9·9 per cent., equals 750 pounds.
Combustible, 6,800 pounds.
Water pumped into boilers, 43,172 pounds.
Steam consumed by pumps and calorimeters, 891 pounds.
Water charged to engine, 42,281 pounds.
Water per I.H.P. per hour, 30·0 pounds.
Coal per I.H.P. per hour, 5·35 pounds.
Combustible per I.H.P. per hour, 4·82 pounds.
Quality of steam, 95·7 per cent.
Moisture in steam, 4·3 per cent.
Dry steam used by engine, 40,460 pounds.
Dry steam per I.H.P. per hour, 28·7 pounds.
Watt hours, per pound of coal, 109·9.
Watt hours, per pound of combustible, 122·1

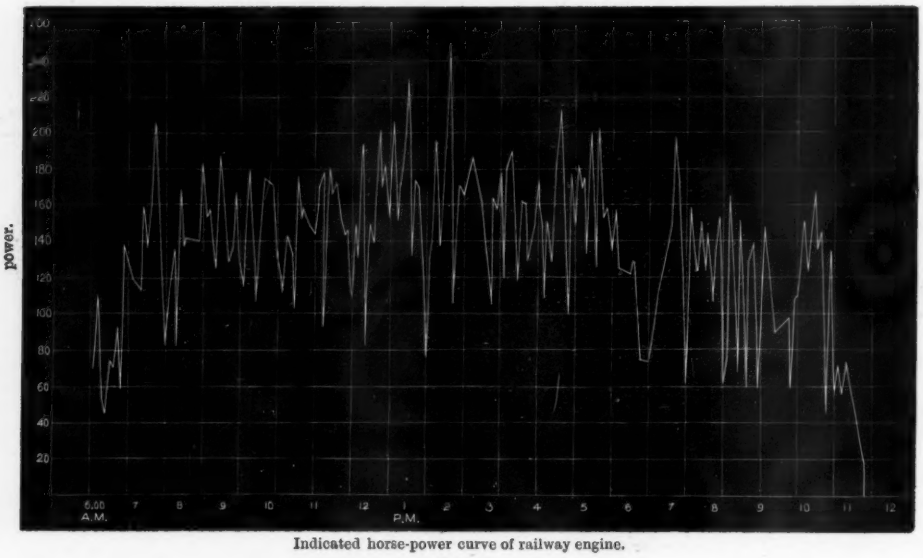
Station efficiency.

6.0 a.m. to 5.30 a.m., 23·5 hours.
Average I.H.P., for 23·5 hours, 160·5
Maximum E.H.P., 350·4.
Average E.H.P., 117·9
Average watts for 23·5 hours, 87,946, which is 2,066,729 watt hours.
Average E.H.P. divided by average I.H.P., 73·4 per cent.
Load factor for 24 hours, 32·4 per cent.
Coal consumed, 17,103 pounds.
Combustible, 15,232 pounds.
Water pumped into boilers, 102,349 pounds.
Steam evaporated and charged to engines after subtracting that used by calorimeters and feed pumps, 100,470 pounds.
Water pumped into boilers per engine I.H.P. hour, 27·1 pounds.
Coal per engine I.H.P. hour, 4·5 pounds.
Combustible per engine I.H.P. hour, 4·0 pounds.
Watt hours per pound of coal, 121.
Watt hours per pound of water, 20·8.
Average quality of steam, railway engine, 96·2 per cent.
Average quality of steam, arc light engine, 97·1 per cent.
Average quality of steam, Monocyclic engine, 97·8 per cent.
Average 96·8 per cent.

Dry steam used by engines, 97,214 pounds.
Dry steam per engine I.H.P. hour, 25·8 pounds.
Average I.H.P. of condenser pump No. 1, 2·62.
Average I.H.P. of condenser pump No. 2, 1·96.
Horse-power hours of condenser pump No. 1, 61·6.
Horse-power hours, pump No. 2, 9·8.
Friction load of engine No. 1, 22·4 with shaft.
Friction load of engine No. 2, 12·2 without shaft.
Friction load of engine No. 3, 22·5.
Total friction load, 57·1 I.H.P. = 11·8 per cent. of maximum I.H.P.

load the steam pressure is ordinarily carried about 45 pounds lower than the full load pressure, in order to keep the engines at a fairly economical cut-off.

During the past three years several papers have been read before this society dealing with the operation of electric railway stations, but no authoritative records appear which cover the operation of the average small station, which combines in one the requisite plant for electric lighting and electric railway service. The individual action of engines,

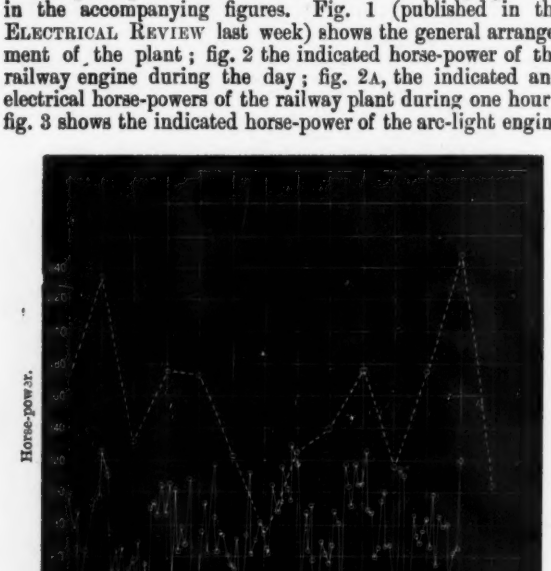


Indicated horse-power curve of railway engine.

FIG. 2.

CONCLUSIONS.

The principal results of the tests are shown graphically in the accompanying figures. Fig. 1 (published in the ELECTRICAL REVIEW last week) shows the general arrangement of the plant; fig. 2 the indicated horse-power of the railway engine during the day; fig. 2A, the indicated and electrical horse-powers of the railway plant during one hour; fig. 3 shows the indicated horse-power of the arc-light engine

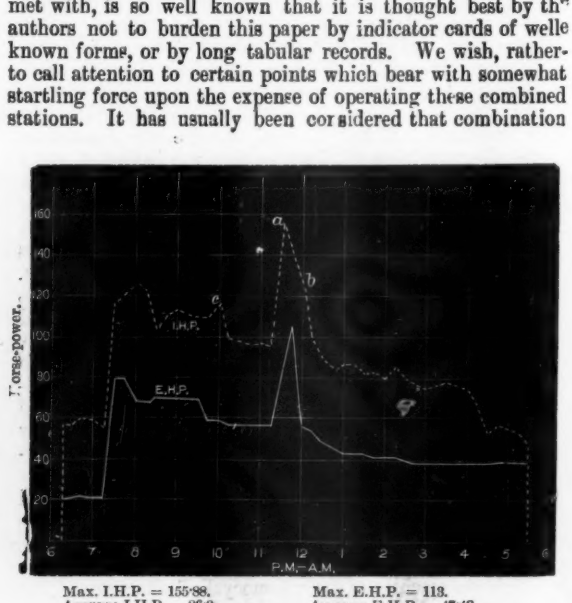


A, Indicated horse-power; B, Electrical horse-power.

FIG. 2A.

and the electrical output of the dynamos driven from it; fig. 4 shows the same thing for the direct-connected engine. In fig. 5 the full line shows the total indicated horse-power developed in the station during the test, while the differently shaded areas show the part played by each of the three engines. Fig. 6 shows the variation of the steam gauge reading during the test; the corresponding corrected pressures are 7 pounds lower. During the period of lightest

dynamos, and auxiliary apparatus, under the conditions hereto met with, is so well known that it is thought best by the authors not to burden this paper by indicator cards of well known forms, or by long tabular records. We wish, rather, to call attention to certain points which bear with somewhat startling force upon the expense of operating these combined stations. It has usually been considered that combination



Max. I.H.P. = 155·88.
Average I.H.P. = 86·9.
Average for 24 hrs. = 39·8.
Load factor = 25·6 per cent.

Max. E.H.P. = 113.
Average E.H.P. = 47·48.
Average for 24 hours = 19·7.
Load factor = 17·4 per cent.
Av. efficiency = 53·5 per cent.

a, Westinghouse alternator, started 11·15 p.m.; b, Nos. 1 and 3, arc machin stopped; c, No. 1, Arc machine, stopped 10·05 p.m.

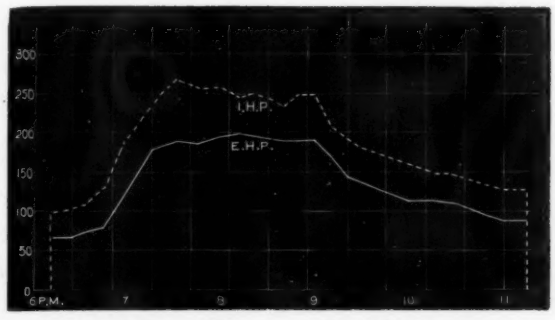
FIG. 3.—ARC LIGHTING ENGINE.

stations may be operated at much less total expense than is required for the operation of two small stations when the lighting and railway plants are separate. This question may be considered under four heads. First, station labour; second, fuel economy; third, superintendence; fourth, fixed charges.

1. In regard to station labour, the plant under consideration (which we will call the Four Lakes plant) probably could not be improved, and if the lighting and railway

divisions were separated, not less than 7 men would be required where 5 men are now employed, and the labour account would be proportionally larger for two stations than for one.

2. The fuel economy of the Four Lakes plant is fully equal to that of the average medium-sized plant, but it is probably no better than would be given by similar engines and other machinery in separate plants. The coal used during the test was a mixture of Indiana block, costing $3.35 per ton, and Illinois coil, costing $2.72 per ton. The evaporation shown by the boilers was, on the whole, excellent, considering the kind of coal used, and the fact that the boilers *were in regular service condition*. The fuel economy of the Four Lakes plant could be improved by several minor changes; this is especially true in regard to the arrangement of the dynamos, which now require the countershaft to be unnecessarily run all day, and in regard to the piping, which might be readily changed to deliver better steam. (Some of these changes have already been made since the test.) But these changes would not give the combined plant any advantage over the separate plants. Better fuel economy would also be obtained by closer attention to the details of operation than is given in this plant, but the watt hours developed per pound of coal and per pound of water compare favourably with the reports of the National Electric Light Association for similar stations.



I.H.P. load factor 24 hrs. = 14·56 per cent. E.H.P. load factor = 15.17 per cent.
Maximum I.H.P. = 267·86. Maximum E.H.P. 198·5.
Average I.H.P. = 186·26. Average E.H.P. = 140·4.
Average efficiency = $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ = 75·3 per cent.

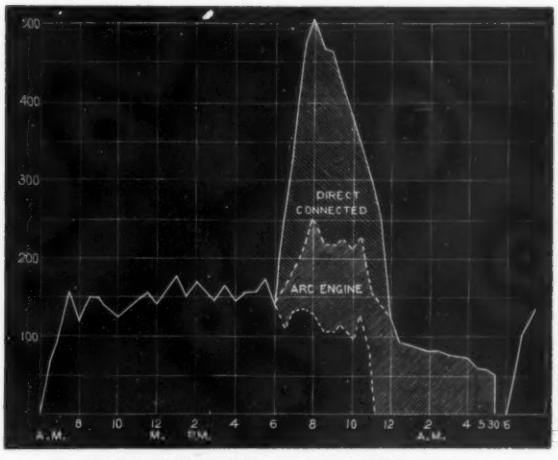
FIG. 4.—DIRECT CONNECTED ENGINE.

3. The question of superintendence requires consideration from two sides; first, where the railway and light companies are independent, and the latter sells power to the former; and, second, where one company controls both industries. In the first case, no saving is made in office force or superintendence by combining the stations; but, in the second case, a saving is doubtless effected by the combined plant.

4. The preceding divisions give little clue to the best solution for the electric plants of the smaller cities, and we must find the solution in this division. The fixed charges which may be rightfully considered as belonging to the station account depend upon the cost of real estate, buildings, and the machinery in place. The first two items are undoubtedly increased to some degree in the separate plants, but not so largely as might be imagined, since the running machinery for the two classes of service must be entirely independent. It is practically impossible for any engine to drive the extremely variable load of an electric railway and regulate with sufficient accuracy to give satisfaction when driving dynamos for electric lighting; and, since the underwriters have taken the matter in their hands, it is not permissible in most places to operate stationary motors from railway circuits, on account of the fire risk involved in introducing grounded circuits into buildings. On account of this separation of the two classes of machinery the real estate and buildings required for combined railway and lighting plants must be larger than would be necessary for either a simple lighting plant or a simple railway plant of a capacity equal to the combined plant.

TOTAL I.H.P. CURVE.

Average I.H.P. = 160·5. Maximum I.H.P. = 505.
Total load factor = 32·4 per cent. Average I.H.P. for 24 hours = 157·1.



Maximum I.H.P. = 245·1. Average I.H.P. = 131·2.
Load factor = 38·2 per cent.

RAILWAY ENGINE.

FIG. 5.

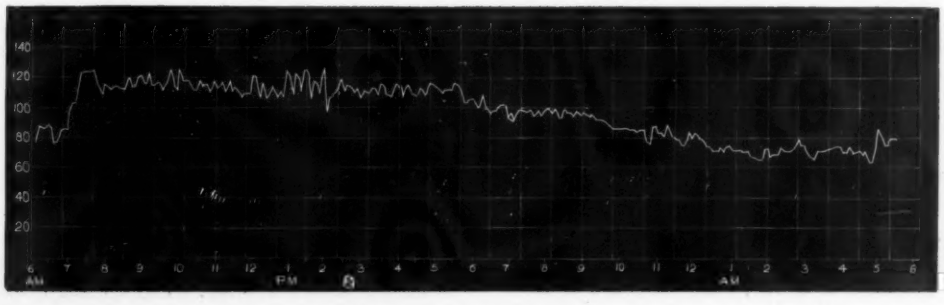


FIG 6.—STEAM PRESSURES.

The comparison of the load factors of separate and combined plants throws no particular light on this question. Thus, in the Four Lakes station, the 24 hours' engine load factor for the railway machinery, plus the day alternator, is 38 2 per cent. For the arc-light machinery alone it is 25·6 per cent.; for the direct-connected alternating machine it is 14·56 per cent. The total load factor of the station is 32·4 per cent. The term "engine load factor" is used here in its usual signification of the ratio between the actual indicated horse-power hours' output of the station and the output which would be produced were the station run continuously at its maximum indicated load. Now, upon separating the lighting and railway outputs, we still have the railway load factor about 38·2 per cent. and the lighting load factor becomes about 23 per cent. Practically the same amount of

boiler power is required in the combined stations as in the separate stations, and exactly the same plant in engines and dynamos are required in the two cases. The boilers, engines, and dynamos are each run at about equal average loads in the two cases, and the efficiencies are not materially different.

We therefore make the following gains by combining the electric lighting and railway plants of small cities into one station. First, a fair amount in the labour account; second, a small amount in the real estate and building account. The gains are not nearly so great as are sometimes asserted, nor are they comparable in magnitude to those which result from the combination of two small electric light stations in one, or two small electric railway stations in one, since, in the latter cases, one economical plant of machinery may be used to do the work of two smaller and less economical plants. When a railway and a lighting station are combined, we are forced by the conditions to use separate machinery (excepting boilers) for the two classes of service.

A NEW SHAFT GOVERNOR.*

By E. J. ARMSTRONG, Oswego, N.Y., Member of the Society.

Probably the most essential qualification of a good governor is stability. A small drop in speed, under load, usually does no harm, but instability is a fault not to be tolerated; to combine stability, sensitiveness, and close regulation, has always been a difficult problem. In the single-weight type of governor, originally invented by our Past-President, Prof. John E. Sweet, and built by him and others

Fig. 1.

for a number of years, the principle aimed at has been to employ a heavy fly-weight, revolving in the largest possible circle, and to reduce the inertia and friction of all connected parts to a minimum. So designed, the action of the governor is extremely quick, passing through its entire range in one-quarter of a second, when the full load is instantly thrown on or off. If not adjusted too close to isochronism, the stability is nearly perfect. Two per cent. drop between no load and five-eighths cut off, equivalent to about 1 per cent. between no load and one-fourth cut off, will, at 300 revolutions, give such a degree of stability that, with the load held steady by Prony brake, indicator cards traced continuously for a minute, show lines only about $\frac{1}{32}$nd of an inch wide at any point. Much closer adjustment is liable to develop a tendency to race, and is for that reason impracticable. This unavoidable drop, while very seldom being of any consequence in actual service, has sometimes been urged as an objection, perhaps by the other salesman, and it has seemed desirable to, at least, be able to give closer regulation. Being unwilling to secure a smaller drop in speed by any device which would affect stability, or in any way retard the quick response of the governor to a change in load, the writer devised and built a governor, in which a shifting weight was employed, as shown in figs. 1 to 3, so arranged that for every position of the governor there would be a corresponding point of equilibrium for the shifting weight. If there is a certain drop in speed between the extreme outer and inner positions of the governor (figs. 1 and 2), the shifting weight and the curved chamber in which

Fig. 2.

it rolls are so proportioned that its weight, transferred from one position to the other, will just balance this drop, by changing the centre of gravity of the governor weight as a whole, and so maintain a uniform speed throughout the governor range. To illustrate: suppose an engine running, say, 300 revolutions without load, and the governor weight in the position shown in fig. 2, the shifting weight being in its outer position. Upon a heavy load, requiring three-quarter cut-off for its negotiation, being suddenly thrown on, the fly-weight will immediately take the position shown in fig. 3, and will drop to, say, 295 revolutions; then the shifting weight, being out of equilibrium, rolls over into the position of fig. 1, in which position its leverage upon the spring is reduced, and it must in consequence run 300 revolutions

Fig. 3.

to again balance the spring. The shifting weight is simply a short, solid cylinder, and the curved chamber in which it rolls is filled with oil. Its fit in this cylinder is sufficiently loose to permit the passage of oil past it, as it rolls from one position to another, thus acting as a dash pot, to prevent its movements being rapid enough to interfere with the stability of the governor. The effect is to make the governor practically isochronous. Instantaneous changes of load are not usually of large amount, and, therefore, the error the shifting weight has to correct each time is small. If the loads change more gradually, the speed does not vary at all perceptibly, for the shifting weight corrects for each small change nearly as soon as made. It is entirely practicable to over-correct in this manner, and so produce a governor which will run considerably faster loaded than light. Just how far this can be carried the writer does not know, but its capabilities in this direction are certainly beyond any probable requirements of practice. Arranged in this way, and with the load slowly applied, the tachometer needle steadily moves upward, precisely as with

* Presented at the Detroit meeting (June, 1895) of the American Society of Mechanical Engineers, and forming part of Vol. xvi. of the *Transactions*.

the ordinary governor it moves downward under the same conditions.

A variation of the scheme, upon which the writer is at present experimenting, consists simply in the use of oil or

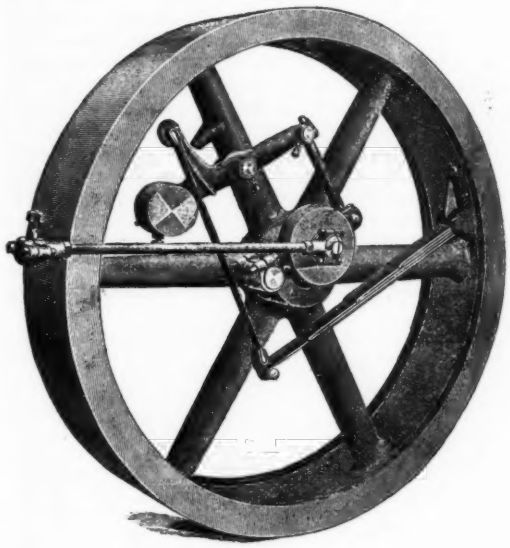
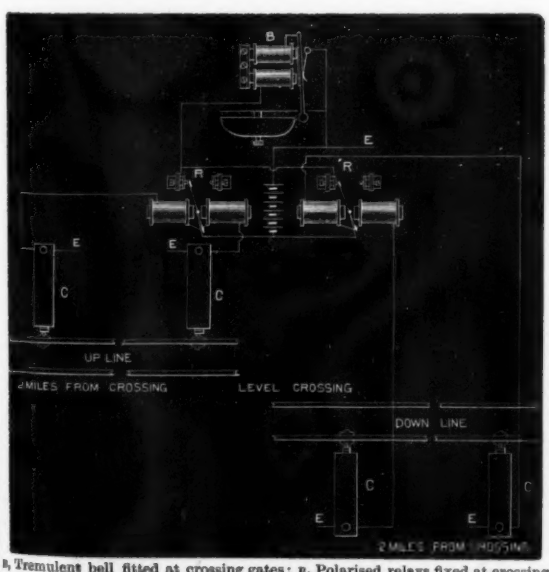


Fig. 4.

other liquid, as the shifting weight; this has the advantage of permitting a small weight to be shifted through a large range, which is quite desirable, and it is also somewhat simpler, though the device illustrated adds but one moving piece to the governor.

AUTOMATIC ALARMS FOR LEVEL CROSSINGS.

In view of the many accidents that occur at level crossings, some form of automatic alarm which will signal the approach of a train would seem to be indispensable. It is not, however, an easy matter to design apparatus which is simple in its construction, and whose working is not likely to be interfered with in bad weather.



B, Tremulent bell fitted at crossing gates; R, Polarised relays fixed at crossing house; C, Tyers' mercury rail contact.

By the courtesy of Mr. John Neale, the engineer of the North Staffordshire Railway, we are able to show the arrangement used on this line for automatically ringing a bell at level crossings by the approaching train.

The slightest deflection of the rail, caused by the train, makes a mercury contact in the treadle, which puts the relay on, and when passing over the treadle at the crossing takes it off again.

The bell is rung with the local circuit through the relays, so long as there is a train approaching in either or both directions.

Although this arrangement at first sight might appear to be rather delicate, it is interesting to mention that it has been in successful operation for the past six years.

CHELMSFORD ELECTRIC LIGHTING.

The street lighting of Chelmsford was until the year 1889 effected by means of 187 gas lamps, but in that year competition between electric lighting and gas was commenced. The electric lighting contract began on April 14th, 1889, and ran on to early in the present year, being now renewed until 1899. The light was formally inaugurated in April, 1890, and in our issue of April 18th, of that year, we gave a few general details of the installation. The lighting started with 18 10-ampère arc, and 202 32-C.P. incandescent lamps. With the exception of a few underground crossings, all the wires were on the overhead system.

The plant originally installed in the engine room comprised a 140 H.P. vertical Marshall engine, running at 120 revs. per minute, driving by ropes a short length of shafting, to which were belted a Mordey alternator of 37½ kw., a Crompton arc lighter, a low-pressure Crompton dynamo of 40 kw., and a small exciter. Steam was supplied from the shop boilers in the works of Messrs. Crompton & Co., and duplicate plant was also fixed in another part of the same works, and driven from their shop engine—of the Marshall horizontal type. During the first year's working, it was found desirable to fit up the alternators with armatures of a more modern pattern, thereby bringing their total output up to 42 kilowatts.

The demand for private lighting was such at the end of 1891 that it became necessary to provide for an increasing load, and this necessitated entire rearrangement of the plant. At either end of a line shafting was connected a Willans H.H. engine, the shafting which was in three lengths, connected with clutches, being driven direct at 350 revolutions. To each length of shafting were belted an alternator, exciter, low pressure (110 volts) machine, and an arc lighter, save the centre shaft, which had no arc lighter. A Lancashire boiler 8 feet × 30 feet was added to the existing boilers, and the steam piping, hitherto a single line, made into a ring main. A new switchboard, with omnibus bars behind glass fronts, and spring switches arranged so as to lock a door in front of each when in the "on" position, was added. A few months later the load still increasing, necessitated the removal of the arc lighters on to a new Willans E E engine. The rearrangement and extension of the plant had been carried out in a way to use, as far as possible, the existing alternators, arc lighters, &c., and therefore no further rearrangement to meet increasing load was feasible, except increasing the size of alternators. This was done by replacing one of the small alternators by a 50 kw. Crompton-Brunton alternator. The next addition was a 3 G S Willans engine, driving at one end a 100 kw. Mordey alternator, and at the other a Crompton low pressure machine. As time did not allow of a special alternator being built, the present machine, originally built for rope driving, was fixed and driven by a flexible coupling. All the low pressure machines are used for lighting, and driving the motors throughout the Arc works, the generating plant being used for the purposes of both Messrs. Crompton & Co. at the Arc works, and the Chelmsford Electric Lighting Company.

For convenience the arc lighter, not driven by the Willans engine, is direct coupled to a low pressure motor, and runs from a low pressure dynamo or off the battery. The most recent alteration to meet the increased lighting load expected during the coming winter is the substitution of a direct-

driven Crompton-Brunton alternator in place of the direct-driven countershaft on one of the Willans engines. This dispenses with a 37½ kw. alternator, an exciter, and low pressure machine, with all their belts, the removal of the last-mentioned machine being made up for by another direct coupled Willans set.

The switchboard has again been extended and modernised by providing for the control of all main alternator circuits and synchronising circuits by plug switches instead of spring switches. Further boilers have been added, with mechanical stokers to some, and liquid fuel apparatus to one. Economisers and superheaters are also at the moment being arranged for. The feed pumps, stokers, water softener, &c., are all worked by motors.

The above historical record denotes the stages from entire rope and belt drive to direct driven counter-shafting and belt driven machines, culminating in everything direct driven, whether it be actuated by an electric motor or a steam engine. This has, we understand, resulted in economy being effected at each stage. The use of accessories such as

Lighting of Rainsford End, Chelmsford, Arc Circuits Underground, Incandescent Circuits Overhead.

electric pumps, liquid fuel, &c., already mentioned, is the outcome of economical considerations, and being on a small scale, is said to be typical of the trend of central station practice.

The work of the Chelmsford Electric Lighting Company really begins where the mains leave the generating station. There are four street circuits for incandescent, five for private lighting, and one for arc lighting, representing the wires which, passing from the engine room to an H-piece fixed to an adjoining building, are taken in various directions over Chelmsford. The town is in the shape of a horseshoe, one end of the shoe forking into two roads, and one main road running out from the centre of the curve. There are thus four directions in which the wires run from the works. The greatest distance at which lamps are situate from the alternator is about two miles. About 15 miles of streets are provided for with 60 miles of overhead wires, the number on a pole varying generally from two to six. All street lighting transformers are in metal boxes on poles, while those for private supply are in transformer chambers.

The overhead wiring consists of insulated cables suspended by leather tags from steel bearers. The poles are of pitch pine, socketed and fixed in circular cast-iron sockets, and after six years' use they show no signs of decay. Besides certain portions of the wiring placed underground for convenience or appearance, about one mile has been laid underground to meet the wishes of the Board of Trade. This is either in Callender or Doulton casing, chiefly the latter.

We understand that there are only two cases on record of wires breaking, one a T-joint near a pole extinguishing two street lights, the other a high pressure private supply wire, which proved to be a defective joint under the original insulation. On the other hand an omnibus colliding with an arc lamp pole, broke the socket, but the wires prevented the pole falling, although the shock sent the lamp flying.

On three occasions trees have fallen, or have been felled, across the wires without breaking them. In one case the wires held up the tree; in another the wires touched the ground, but did not break, one pole breaking and one bending; in the latter case, both were 5-inch wrought-iron poles, and

Lighting of Tindal Square, Chelmsford.

were permanently bent, but the wires did not break. With the exception of an accidental fall from a ladder, there has been no mishap to any employé. The steel wires undoubtedly to some extent protect the lines from lightning, as during storms discharges from the steels to the earth wires or ironwork are visible. But no discharge has ever reached the engine room.

The unsightliness of the wires cannot be considered to count for much, as although the gas standards are disconnected from the gas company's mains, and dismantled, the Corporation whose property they are have not, after five years, considered it worth while to remove more than about a dozen of these relics of the past. The arc lamps were originally fixed above the poles on crutches, but are now mostly on swan-necked brackets. The height of arc was 25 feet from ground, and is now about 20 feet. Clear globes were originally used, but opalescent have since been adopted. The Crompton-Crabb circular lamps, with which the installation started, were replaced 2½ years ago by Crompton-Pochin lamps. They are, on an average, about 70 yards apart, but opposite the Shire Hall and Tindal Square, of which we show a photographic view, the lamps are only 30 to 40 yards apart. The

arc lighting at present consists of 21 lamps (10 ampères) in series. For the incandescent lighting, there are about 240. Each lamp is for 110 volts, and is coupled on a parallel circuit, with 12 lamps to a transformer. The greatest distance from a transformer to a lamp is 400 yards; the height of lantern from ground, 16 feet. There is a fuse on the pole to every lamp. As in the case of the arc lighting, the incandescent lamps are 70 yards apart in outlying roads, but only 45 to 50 yards in more important streets.

Two points have to be observed in lighting with incandescents—first, as lamps blacken, higher C.P. lamps should be used than appear right on trial; 8-C.P. seem useless; and 16-C.P. in regular use (unless often renewed) are found to be hardly good enough. Secondly, the filaments break without notice, and the most careful inspections will not prevent extinctions. Therefore either automatic devices, which are troublesome and expensive, for switching a second lamp in must be used, or two smaller C.P. lamps used in each lantern.

Lighting of New London Road, Chelmsford. Incandescent Mains for Private and Street Lighting Overhead.

Arc lighting costs £22 10s. per lamp per annum; incandescents, £2 6s. 10d.

These prices were not fixed as being the right value for the article supplied, but made up a lump sum of £750 (now over £1,000), which price ended in the extinction of gas in Chelmsford streets. As these prices have been the subject of criticism by one of our contemporaries, we may mention that although they are more favourable to the Corporation of Chelmsford than to the Lighting Company, we understand they have proved fairly satisfactory as a nucleus round which to form a sound undertaking.

The growth of private lighting is instructive for similar undertakings. At first there were, of course, only a few premises connected. Two years after starting there were only about 600 private lights (meters substituted for rentals). At the end of the year 1893 there were nearly 1,000 lights, and the sliding scale was abolished. A uniform 6d. rate was introduced at the end of 1894 with over 2,000 lights; at present there are about 3,000. 75 per cent. of these are in shops and business premises, which fact points to the slowness with which the private residents of a country place like Chelmsford adopt the light. In conclusion, we may mention that the transformer chambers are now built of concrete, with arched roof 6 feet 6 inches high, width inside about 4 feet by 7 to 8 feet deep. The transformers originally used were Hedgehog and Mordey types, but subsequent to 1892 all have been of Messrs. Crompton's make, with Cardew earthing devices.

THE LIGHTING OF THE EMPIRE OF INDIA EXHIBITION.

The glories of the Empire of India Exhibition have been adequately set forth in the columns of the daily press. It is not too much to say that it is the finest Exhibition that has been held on the Earl's Court site. There is more solidity and less of the tinsel than one is accustomed to in similar shows; in fact, everything points to permanence; certainly many of the buildings have been designed to that end.

The lighting of the series of Earl's Court Exhibitions has from year to year shown something interesting, but the arrangement this year surpasses everything that has been done previously. In the first place there are many more lights needed, and the lighting is required for many very different purposes. When we mention that there are some 300 arc lamps distributed over the grounds, and 8,000 incandescent lamps used in the numerous buildings, some idea may be gauged of the importance of the scheme.

Mr. G. C. Fricker, M.I.E.E, who has been intimately associated with the lighting of most of the previous Earl's Court Exhibitions, has designed and carried out the lighting arrangements throughout.

The generating plant, which is placed in an entirely new building, consists of nine steel locomotive boilers, each evaporating 300 to 350 gallons per hour. The engines which

employed for driving three of the alternators are new to central station work, being made by Davey-Paxman on Peache's patent. There are two three-cylinder compound single-acting engines, each capable of indicating 180 H.P. at 325 revolutions per minute, coupled direct to 100-kilowatt Mordey alternators. In addition, is a one two-cylinder engine of similar design coupled to a 75-kilowatt Mordey alternator. An interesting feature of the lighting plant is a horizontal Colchester compound engine, indicating 200 H.P. at 100 revolutions, driving countershafting from which four Brush 55-light arc machines and one 25-kilowatt Brush-Vienna low-tension machine are run. The remaining plant comprises a horizontal Colchester compound engine, indicating 120 H.P., driving a Mordey alternator (75 kw.) by belt direct from fly-wheel, and a coupled compound girder engine driving Brush arc machine and low tension Brush direct-current machine by belting direct from fly-wheels. The alternators are of the latest Mordey type, and have the exciters coupled on the alternator shaft. The wires are led from the alternators to a switchboard, which has been erected in the centre of the engine room. Each alternator has its own main switchboard, with slide resistance for regulating exciting current, ampèremeter and voltmeter for alternator, armature circuit, double pole trigger switches, and Bate's fuses. By means of rock-over switches any alternator can be excited from one of the belt-driven low tension machines in case of failure in coupled exciter. There are 16 primary circuits, each carrying 10 to 12 ampères. Each circuit is arranged on a double pole plug board with trigger switch and double pole Bate's fuses, so that it can be plugged on to either one of the alternators. Thus perfect control in the adjustment of load is secured without parallel running of the alternators.

Mordey transformers are used in all the sub-stations, and in these there is no "banking."

All the primary cables are run in iron pipes underground, excepting some of the arc circuits inside the buildings. Secondary incandescent circuits are in casing or stretched on insulators.

Mr. A. Money is the engineer in charge, and has given Mr. Fricker great assistance in laying down and arranging the plant.

In a subsequent issue we shall have something more to say of the different methods of lighting.

CORRESPONDENCE.

New Use for Old Insulators.

It is so seldom we can get the start of our friends the Americans, that, perhaps, I may be excused for mentioning that Englishmen and Germans have long since found out a "A New Use for Old Insulators," as referred to in your paper of to-day.

If any enterprising antiquarian in this respect will go down to Charlton, in Kent, where Messrs. Siemens's works are situated, he will see quantities of front gardens in that neighbourhood where defective insulators are largely used as border edgings, so that they almost identify the residence of one of Messrs. Siemens's workmen, or if he likes to take a more extended sphere of observation, he will often find throughout the United Kingdom small cottage gardens similarly decorated; and, as a rule, he may come to the conclusion that a telegraph lineman lives there. By the same rule, he will often find clothes lines in gardens composed of No. 8 iron wire, and he may also conclude that a telegraph lineman (his wife being a washing lines woman) lives there.

I should not have mentioned these little facts in natural electrical history, but for your article referred to.

Charles Curtoys.

July 12th, 1895.

A Curious Incident.

A very curious incident happened a short time ago upon an electric light installation which I put up in a water mill near Ipswich, and I shall be much obliged if you could explain the reason, which I was unable to find out. I had a very small model motor which could be driven with ease by a "Volta" battery of six cells, which I then had. Wondering what the effect would be were this coupled to a cord upon which an 8-C.P. incandescent lamp was hanging, I took off the lamp and fastened the wires to the terminals of the motor. No sooner had I switched on the line to which the motor was connected, than the strap which was driving the dynamo (which was a machine of 100 volts, 10 ampères) was thrown off, with the result of all the lamps being extinguished. This was done six or seven times successively. I noticed that the armature on the motor always stopped in a position parallel to the two ends of the horse-shoe magnet. I should be much obliged if you could give me any hints as to the cause of this.

Charles F. W. Dudding.

July 12th, 1895.

[The result was doubtless due to the low resistance of the motor acting as a short-circuit to the dynamo; the latter would consequently be suddenly arrested in its motion, and this would suffice to cause the strap to be thrown off.—Eds. Elec. Rev.]

LEGAL.

Direct Spanish Telegraph Company, Limited, v. the Owners of the "Caloric."

This was the appeal (heard on Tuesday) of the plaintiffs from the judgment of Mr. Justice Day, sitting in the Admiralty Court, with Trinity Masters, in an action to recover damages for injuries alleged to have been done by the defendants' steamship *Caloric* to the plaintiffs' telegraph cable in Bilbao Bay. It was alleged that the *Caloric's* anchor fouled and cut the cable, and that there was a want of skill and care in the management of the ship. Mr. Justice Day held that there was no negligence on the part of the ship, nor was he satisfied that the cable was damaged in the way suggested. Judgment was given for the defendants with costs. Hence the appeal of the plaintiffs, who were represented by Mr. A. Cohen, Q.C., and Mr. B Aspinall; whilst Sir Walter Phillimore and Mr. H. Holman appeared for the respondents.

Without calling upon the respondents' counsel, the Master of the Rolls said it was all very well to say that a captain ought to have sacrificed his owner's property in order to save somebody else's; but the only question was: Did the captain do anything which by ordinary care and skill any other captain would not have done, or did he not do something which he ought to have done? The learned Judge below was advised by his nautical assessors that neither of these propositions could be made out against the captain, and the gentlemen who advised the Court of Appeal were of the same opinion. There was nothing like negligence of any kind.

Lords Justices Kay and Smith concurred, and the appeal was accordingly dismissed with costs.

BUSINESS NOTICES, &c.

Agency.—Messrs. Johnston Benjamin & Co., of Wenlock Road, N., inform us that they have been appointed agents for the sale of the E N.S. dry batteries in the following towns:—London, Birmingham, Bristol, Brighton, Hull, Manchester, Bradford, Newcastle, Edinburgh, and Glasgow.

Annual Outing.—The employés of the Electrical Company, Limited, 122—124, Charing Cross Road, and the employés of the Calmon Asbestos and Rubber Works, British Agency, of the same address, together with a few guests, and accompanied by the managing director, Mr. F. T. Eggers, held their second annual outing a few days ago. The party started by rail from Paddington to Maidenhead, from whence, by an electric launch, the party proceeded to Great Marlow and Henley, passing through the Thames Valley. Lunch was enjoyed on board, and tea was served at Marlow on the return journey. In the evening a sumptuous repast was partaken of at Skindle's Hotel, Maidenhead Bridge.

Belt Fasteners.—Messrs. C. J. Edwards & Sons, of Great Sutton Street, E.C., have brought out the "Silvril" Butt joint fastener for leather, India-rubber, gutta-percha and canvas belting. It is claimed that this fastener enables a perfect endless belt to be made; it is intended for every kind of drive, especially very high speeds over small pulleys.

Catalogue.—A neat little catalogue has been brought out by Messrs. Newington, Priddle & Co., of Great Sutton Street, E.C., dealing with electric lighting plant and accessories. There is a variety of spring contact and other switches, switchboards and excess indicator for dynamos or accumulators, which the firm manufactures under a license from Messrs. Drake & Gorham. The catalogue, which is arranged to allow of further sheets being interleaved, is nicely illustrated.

Country House Lighting.—Messrs. Ernest Scott and Mountain, Limited, have secured the contract for the electric lighting of Grey Towers, the residence of A. J. Dorman, Esq. The installation will be of a particularly complete character when finished, and will consist of a Cornish boiler supplying steam to a vertical high-speed steam engine which will drive an Admiralty type shunt-wound dynamo feeding accumulators capable of storing current for 225 lamps. There will be about 250 lamps in all throughout the house and stables. Mr. Dorman has also decided to drive the laundry machinery by electric motors, and the pump for supplying water to the house will be driven in a similar manner. It is further contemplated carrying the cables to the Home Farm, where the farm machinery will be driven by electric motors. Messrs. Scott and Mountain are extremely busy in their electrical and engineering departments. The Admiralty have recently decided to adopt electrically driven fans for the ventilation of war ships, eight of this firms improved fans being in hand for H.M.S. *Venus* and *Diana*, and H.M.S. *Juno* and *Doris*.

New Electric Heating Arrangement.—We illustrate below a new arrangement of electrical hot-plates recently brought out by Messrs. Crompton & Co. The three hot-plates are made to fit into a brass stand, and any or all the plates may be used at one time. If necessary each plate may have the new patent pin switch connector, which cuts out one or more of the heating circuits by a quarter movement of the connector. This action does not involve the removal of the connecting socket with consequent sparking at the pins, hence the trouble of burnt connections is obviated. Sometimes it is found advisable to do without regulating contrivances and have plates made to reach different degrees of heat; thus, the first might be a slow plate reaching a maximum temperature of 300° F.; the next would reach 500°; and the third 600° or 700°. These temperatures would give all the variations necessary in preparing a small dinner, and the utensils would be moved from one heater to the other as required. When the three plates are used for cooking purposes the current may vary from 2 to 5 ampères per plate. 2, 3, and 5 would probably be the best arrangement where the heating effect is required to be different in each plate. When used only as warming plates, the current required is about 1 ampère per plate, at 100 volts. A number of heaters of this type are now in use in West End houses, and they are found invaluable for keeping food warm during dinner. The stands are nickel-plated. The plates are each 8 inches in diameter.

Elmore.— We have not heard much of the Elmore Copper Companies lately. A year or so ago it was quite a common occurrence to see plaintive epistles in the financial papers from the pens of shareholders. We remember when some of the debenture-holders of Woodhouse & Rawson United were discussing what they should do with the late directors, one speaker made a great point of the value as assets, of some Elmore holdings. Whether the special securities then referred to are, or are not, worth the values then placed upon them will be evidenced in the development of time, as has been the case with associated companies' shares. "Verax," writing to the *Financial News*, rakes together the remaining fragments of the Elmore's Foreign and Colonial Copper Company, which, by the way, gave birth to some other copper-depositing companies, at least one of which succumbed to financial diabetes, and a combination of hereditary diseases, which ended in it being sold for the price of old iron to a French clique, We reproduce his remarks without any further comment:—"The directors of this company have recently invited the shareholders to subscribe for £7,500 7 per cent. first debentures, secured upon a portion of the company's securities, the nominal value of which portion is about £87,000. The money is required 'for the purpose of wiping out the remaining few liabilities of the company, and to enable the board to deal to the best advantage with the unsold patents and the securities they hold.' The directors further add that 'the security offered is ample; the rate of interest and the bonus on redemption in three years are high.' It seems, however, that the response of the shareholders, so far, has not been satisfactory, and an urgent appeal is again being made by the directors for subscriptions *pro rata*. Now, sir, it appears to me that our directors can scarcely be surprised that the priority-holders, at least, are somewhat reluctant in subscribing after the treatment which they have received in the past. When the prospectus of the company was issued it was distinctly and emphatically stated in leading type that the priority-holders were to receive the return of the par value of their shares (£5), together with a premium of 100 per cent., out of the first profits of the company. The £5 was returned out of part of the profits on the sale of the French and German patents; but the whole of the cash profits (some £45,000) made by the sale of the American and Canadian patents were quietly handed over as a loan to the French company, instead of being returned to the priority-holders, in accordance with the terms of the prospectus. Not only was this done without the consent of the priority-holders (except, perhaps, a few privately consulted), but without first securing sufficient support from the French shareholders to render that loan efficacious and satisfactory. And what is the result? This cash loan of over £40,000 has virtually dwindled down to so poor a security that the directors cannot, apparently, raise even £7,500 upon it to clear off their liabilities. When it is further considered that according to our last balance-sheet the par value of the securities held by the company amounted to over £160,000, apart from the value of the unsold patents, it is indeed a sarcasm on the past management of the company to find these liabilities of some £8,000 a very pressing difficulty. Such results as these are not calculated to encourage subscriptions, and if money has to be raised in order to avoid the sale of securities at depreciated prices, especially now, 'when,' as the directors say, 'the company will shortly be able to deal with its assets in a way which cannot fail to be satisfactory to the shareholders,' the call should be upon the holders of founders' shares, to whom the reversion of future profits will chiefly accrue. Clearly, from what has been stated above, the priority-holders have virtually handed over already (or it has been done in spite of them) a cash sum equal to a return of £3 per share. Have the founders done as much?"

Summer Number.—Mr. Ernest Croft, the manager of the *Western Morning News*, has sent us a copy of the summer number of the *Western Weekly News*. The great volume of reading matter, which is very interesting, given for 2d. is almost incredible.

The "Heckla" Portable Furnace.—We give an illustration (fig. 1) of a very compact, practical and economical arrangement for melting metals, heating soldering irons, bending iron pipes, tempering tools and many other purposes. It burns ordinary paraffin oil without wick, and is perfectly free from smell, soot or smoke, and can be regulated as easily as a gas jet. Though it gives an intense heat, the consumption of oil is said to be only one-third of a pint per hour. By means of the piston shown in the figure air is pumped into the tank, causing an extremely fine jet of paraffin to circulate through the combustion tubes till it arrives at the orifice and ignites

Fig. 1.

in the form of gas. The "Ætna" brazing lamp, fig. 2, is on the same principle, and is said to be the only lamp of the kind burning ordinary paraffin oil. It will work in wind or rain, and appears to

Fig. 2.

be in every way a most convenient arrangement for use in electrical work of all kinds.

Fire.—On Friday night last an extensive fire occurred at the works of the General Electric Company, Limited, at Manchester, causing considerable damage, which, however, is said to be covered by insurance. We are asked to state that the business of the company will in no way be interfered with, and orders will continue to be executed promptly. The company's heavy stock in its warehouses in London, Manchester, and Glasgow, as well as the manufacturing capacities in its various works and shops at Hammersmith, Clerkenwell, Thames Street, &c., will enable the company to meet all emergencies for the next few months. In the meanwhile the General Electric Company is pushing forward with all possible speed the erection of plant, machinery, and tools in its new works, *i.e.*, Peel Works, Adelphi, Salford, where the company expects to be able to increase the output of its old works.

As a report has appeared in the Press of a fire which occurred last Saturday night at Messrs. W. T. Glover & Co.'s Works at Salford, we are asked to state that only one department of the business was affected, and that all work is being carried on as usual.

On Monday night a fire occurred at the residence of Sir C. Fremantle, 10, Sloane Gardens, Chelsea, owing to the fusion of electric wires.

The Hermite Sanitation Process.—On Thursday, last week, Major Ruck, R.E., and Dr. Tyndall, from Netley Hospital, visited Ipswich for the purpose of officially inspecting the Hermite electrical installation now used in the treatment of the Ipswich sewage.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—The electric light has been introduced at Messrs. Morgan & Co.'s establishment in Little Darkgate Street.

Ashton.—The specifications respecting the electric light installation for the Town Hall are to be submitted to an expert before deciding as to the tenders.

Ayr.—Mr. Robert Hammond, in a recent report to the Town Council, shows that the work of erecting and equipping the central electric lighting station is making satisfactory progress.

Brighton.—The Local Government Board has given its sanction to the Council borrowing the sum of £43,650 for the purposes of electric lighting, and £2,500 for the purpose of public lighting.

Broadstairs and St. Peter's.—The County of London and Brush Provincial Electric Lighting Company has given notice of its intention to apply for a provisional order for electric lighting, &c., in the district. The matter is in the hands of a Committee.

Cardiff.—The Borough Engineer reported that the estimate for the electric works and plant was £32,500, which had been exceeded in the expenditure by £5,000, and he recommended that an additional sum of £7,500 be borrowed to meet that and other extra expenditure. The Committee agreed that the money should be borrowed. The Borough Engineer also submitted an estimate of the working expenses for the whole of the lighting department (including gas and electricity) for the next six months, the total amount being £5,380 10s. The previous budget was £5,580. The figures submitted were adopted.

Channel Lighting.—A double row of 100-C.P. lamps has been placed on either side of the Gedney Channel, Sandy Hook. High pressure current is supplied to the lamps by a submarine cable 6½ miles long, and the lamps are mounted on posts 12 feet high, attached to floating buoys. "In this way," says the *Cork Constitution*, "a narrow channel hitherto impassable after dark has been converted into a comparatively brilliant thoroughfare."

Cheltenham.—A large boarding house in the Western Road, connected with the Ladies' College, is being fitted for electric lighting. The installation will be equivalent to 230 8-C.P. lamps, and the supply will be taken from the Corporation mains. Mr. A. G. Sanders is carrying out the work.

Cowes.—The District Council last week adopted Mr. F. H. Medhurst's report on the surveyor's scheme, and resolved to invite tenders for lighting the town by electricity.

Dewsbury.—The mains are to be extended so that current may be supplied to the Theatre Royal.

Dorking.—The Guildford Electricity Supply Company, Limited, has given notice to the District Council of its intention to apply for a provisional order. The Clerk has the matter in hand.

Hanley.—At last week's Council meeting, Alderman Shirley, in moving the adoption of the General Purposes Committee's report, said the committee were anxious to prepare for the lighting of the extended district, and they proposed to purchase 30 arc lamps from Messrs. Crompton & Co., with cast-iron pillars, for £539. They also proposed that the tender of Mr. Cornes, for the erection of additional buildings required at the electricity works, at his scheduled prices, less 2½ per cent., be accepted, he having done other work, and having his plant there.

Harrow.—There was a lengthy discussion at the District Council the other day, when a subject which had been decided by the old Council was again threshed out. Acting upon the decision of the old Local Board, Messrs. R. E. B. Crompton and W. C. C. Hawtayne wrote requesting the Council to advertise and deposit the draft deed, and submit to the Board of Trade for approval, in the matter of the transfer of the Board's provisional order to the Harrow Electric Light and Power Company. After a good deal of talk, the Council decided to do as Messrs. Crompton and Hawtayne requested, and to adhere to the decision of the old Board as to the transfer of the order.

Ilfracombe.—The District Council having received notice of the intention of a company to apply for a provisional order for electric lighting, are to consider the whole question of lighting, including a proposal to acquire the gas works, at a September meeting.

Keynsham.—At the last Council meeting, there was a discussion as to whether the town should still be lighted by electricity, or return to gas. It was ultimately resolved that the Electric Light Company's contract for "£137 for 77 lamps, and £2 5s. for all additional ones," be accepted.

Kingswood.—Last week, on the recommendation of the Works Committee, the District Council decided to defer the extension of the electric lighting for the present.

Lewisham.—The Capital and Counties Electricity Supply Company, Limited, have given notice to the Board of Works of their intention to apply to the Board of Trade for a provisional order for this district.

London.—We understand that Messrs. Drake & Gorham have been entrusted by Sir Richard Quain, F.R.S., with the entire lighting of his house in Harley Street, and the work is now being proceeded with.

London County Council and Electric Lighting.—At the meeting of the County Council on Tuesday afternoon, the Highways Committee submitted the following report:—"On July 31st last year we submitted to the Council a scheme for the electric lighting of the Victoria Embankment and Gardens, and Westminster and Waterloo bridges, for which purpose the Council obtained powers in its General Powers Act of 1893, and £15,000 was provided in the Money Act of that year. The scheme which we then proposed would have involved a capital expenditure of £20,000, being £5,000 over the amount provided for the purpose, and an annual expenditure for maintenance, and for interest and redemption of loan, of £3,880. The Council, upon consideration of the recommendation, resolved that, having regard to the late period of the year, and to the fact that it would be impossible for the electric lighting to come into full operation by the ensuing winter, the further consideration of the question should be adjourned until the spring of this year. We gathered from the discussion on July 31st that one of the reasons which caused the Council to postpone the consideration of the matter was the increase of the estimate by £5,000; and we have accordingly reconsidered the scheme with a view to reducing not only the expenditure on capital account, but also the cost of maintenance. In connection with this revision it has occurred to us that, having regard to the fact that the embankment gardens, which are not open to the public at night, require to be lighted only a very short time each evening for about three months in the year, the Council would scarcely be willing to incur the expense of lighting them by electricity, especially as they are not now lighted at all. We have therefore, in the new scheme which we have prepared, not made any provision for lighting the gardens, and we think the Council will concur in this. In the revised scheme which we now propose, duplicate plant is provided for, either set of plant being capable of lighting the embankment and the bridges; the generating station is of fireproof construction, so securing the maximum of safety; while the cost of the buildings has been reduced by omitting some of the more expensive items of ornamentation proposed in the original scheme, but the buildings will be quite as efficient. The electric lamp standards would be placed on the kerb of each of the footways leaving the parapet lamps to be lighted, when required, by gas as at present, and the existing lamp standards on the two bridges would be fitted with the electric light. It is proposed to provide 83 lamps in all. We would, however, point out that the light on the Embankment would necessarily be, to some extent, obscured by the trees at the sides of the footways, and we do not see our way to obviate this. Should the Council decide to adopt the scheme, we propose to ask

the Technical Education Board to allow its inspectors of art schools and classes to assist us by preparing designs for the lamp standards; and we hope to be able to obtain a design for a standard and lamp which will be worthy of being placed in this, the finest thoroughfare in London. The capital cost of the scheme is estimated at £16,590, made up of the following items:—Buildings, £4,600; boilers and machinery, £5,200; mains, £2,250; lamps and standards, £4,240; salaries, £300; of which about £3,000 is included in respect of the two bridges. The estimated annual cost of maintenance is £2,768, in which is included—wages, £700; coal, £375; other stores and carbons, £325; repairs, £613; loan (interest and repayment), £672; rates and taxes, £83. In making these estimates, it has been assumed that the repayment of the loan would be spread over 42 years, which is the period for which the Council is now granting loans to vestries for electric lighting purposes. We recommend: That, subject to an estimate being submitted to the Council by the Finance Committee, as required by the statute, the Highways Committee be authorised to take all the necessary measures for establishing, at a cost not exceeding £16,590, electric lighting for the Victoria Embankment and the Waterloo and Westminster Bridges (but exclusive of the Embankment Gardens) authorised by the Council's (General Powers) Act, 1893; and that for this purpose the Committee be authorised to obtain tenders, and to enter into contracts on behalf of the Council." On the motion of Mr. Westacott, seconded by Major Probyn, the discussion on the report was deferred for a week.

Marylebone.—The Vestry has appointed a special committee to consider and report as to the desirability of lighting the parish by means of electricity, the Vestry undertaking the work, and the Committee to be empowered to make the fullest preliminary inquiries of those metropolitan vestries which have adopted this course.

Ossett.—There was a lengthy discussion at last week's Town Council meeting regarding the gas works and electric lighting. The following resolution was passed, with the aid of the casting vote of the chairman:—"That the Town Clerk be, and is hereby, instructed, to prepare a Bill for Parliament for the next session, with the object of acquiring the works and plant of the Ossett and Horbury Gas Company, and also to establish an electric lighting plant, or electric lighting plants, and that the Town Clerk take all the necessary steps for the above purposes."

Poplar.—The Capital and Counties Electric Supply Company has notified the Board of Works of its intention to make application to the Board of Trade for a provisional order for electric lighting.

St. Pancras.—At the Vestry meeting last week, Dr. J. Bell moved the adoption of a report of the Finance Committee, recommending that £75,000 be borrowed from the National Bank at 3 per cent. per annum, mainly for electricity purposes, repayment to be spread over a period of 42 years. It was explained that the total saving effected by obtaining the money from the bank instead of the London County Council would be £5,626, in that the latter required 3½ per cent. With regard to raising the loan by bonds issued by the Vestry itself, the Committee opined that no advantage would result from this, and an initial cost of £500 would be incurred, as against £102 needed to effect the loan from the bank. This was agreed to.

Stafford.—The Council has decided to extend the electric lighting cables along Tipping Street, and as far as the new Baptist Chapel on Lichfield Road.

Surbiton.—The Capital and Counties Electric Lighting Committee have given notice to the District Council of its intention to apply for a provisional order. The Committee have been informed that the Council intends doing the lighting for itself under an order recently obtained. Six firms are to be invited to send in plans and specifications, with an estimate for lighting the district electrically. If necessary, an engineer "of eminence" is to be called in later to report as to the best of the submitted schemes.

Tunbridge Wells.—£12,000 is to be spent on electric lighting extensions, and application is to be made to the Local Government Board for power to borrow the money.

Whitechapel.—The Whitechapel Local Board, the other day, received a notice from the Capital and Counties Electricity Supply Company, Limited, of their intention to apply to the Board of Trade for a provisional order to authorise them to supply electricity for public and private purposes within the area of the Board. The Board are to consider the question.

Withington.—The Manchester Suburban Electric Supply Company have given the District Council notice of their intention to apply for a provisional order for electric lighting during the next session. The councillors seem inclined to secure powers for themselves keeping the work in their own hands, but the matter is under consideration.

Woking.—The Knaphill and Brookwood ratepayers met last week to discuss the lighting question. It was resolved to ask the District Council to adopt electric lighting in preference to any other method.

Yarmouth.—The surveyor's last monthly statement to the Council showed that five more customers had made application for 178 lamps, making the total number of customers 92 for 4,700 lamps. The working expenditure during May was £99 8s. 4d., and the receipts £80 0s. 8d, leaving a loss for the month of £19 7s. 8d.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Dublin Electric Tramways.—The Kingstown Commissioners the other day held a special meeting for the purpose of consulting with Mr. Clifton Robinson in reference to matters in dispute between the Commissioners and the Electrical Tramway Company in reference to the proposed double line through George's Street. After some discussion it was resolved by 11 votes to 6 to allow the company to lay the double line. An amendment allowing a single line only was negatived.

Electric Traction in Egypt.—A company has just been formed in Brussels with a capital of £160,000, to be known as the Société Anonyme des Tramways du Caire, to acquire the 50 years' concession lately granted by the Egyptian Government for the construction and operation of about 18 kilometres of electric tramways in Cairo. The lines are to be on the Thomson-Houston overhead conductor system.

TELEGRAPH AND TELEPHONE NOTES.

Cable Wanted.—The Post Office authorities want to lay a telegraph cable to establish communication between Cardiff and Flat Holme. The Cardiff Corporation are considering the matter before giving permission.

Exports of Telegraph Wire and Apparatus.—The returns which are now available regarding the exports of telegraph wire and apparatus connected therewith from this country during June, show that another exceedingly quiet month has to be recorded in this trade, although not so quiet as May. The exports last month amounted in value to £99,572, as compared with £26,942 in the preceding month, and with £341,646 in June, 1894. The returns for the first six months of the year are exceedingly unsatisfactory, the exports during this period having only amounted to £226,260, as compared with £883,741 in the first half of last year, and £479,195 in the first six months of 1893.

French Submarine Telegraphs.—The *Revue Scientifique* states that France has at the present time 5,330 miles of submarine cables belonging to 54 different lines, while there are three French companies possessing submarine cables—namely, the French Telegraph Company, from Paris to New York, with 4,080 miles; the Commercial Cable Company, with seven cables, having a total length of 10,495 miles, and the French Society of Submarine Telegraphs, with 15 cables, of a total length of 5,260 miles.

Telegraphic Interruptions.—Under the heading "The Telegraph in the Dutch Indies in 1893," published in the *Journal Télégraphique* of June 25th, 1895, we find the following:—"Regarding the cables of the Eastern Extension, Australasia and China Telegraph Company which connect the Dutch East Indies on the one part with Penang and Singapore, and on the other part with Australia, the following interruptions have occurred:—

Cable.			Interrupted.	Repaired.
Banjoewangie-Port Darwin,	No. 1	...	Sept. 27th.	Oct. 10th.
do. do.	No. 1	...	Oct. 26th.	Nov. 4th.
do. do.	No. 2	...	Feb. 23rd.	March 8th.
do. do.	No. 2	...	Mar. 22nd.	April 2nd.
do. do.	No. 2	...	Oct. 25th.	Nov. 7th.
Medan-Penang	...	...	May 28th.	June 2nd.
do.	...	...	July 8th.	July 10th."

Telephone Trunk Service.—The Post Office Telephone Trunk Line Service between London and the principal provincial towns was started on Tuesday last, 16th inst. The officials at St. Martin's le Grand express themselves very well pleased with the amount of business transacted up to the present. The number of talks has fully reached expectations. A considerable share of the work, so far, has been with Cardiff and other towns in South Wales, while the circuits to the North of England, Scotland, and Ireland, have been fairly well patronised. A number of messages have originated with the National Telephone Company's renters, and, for the most part, the company's lines have worked satisfactorily in conjunction with the Post Office circuits. In some cases, however, where a single wire connection has been used to help to make up a specially long circuit, difficulties have been experienced. Conversation from the Post Office boxes at the G.P.O., Stock Exchange, and West Strand, has been uniformly excellent on all circuits.

The Electrophone.—On the occasion of the farewell of Dean Farrar at St. Margaret's, Westminster, his valedictory address will be transmitted by aid of the electrophone to various districts in London. Churches in Soho, Chester Square, Highbury, Marylebone, Birmingham, &c., will be connected with St. Margaret's upon this occasion. The Electrophone, Limited, have carried out the work.

The Pacific Cable.—A New Zealand contemporary, after pointing out that, in view of the position of affairs in Europe and in the East, the need for this cable becomes more and more apparent, goes on to say:—"Mr. Sanford Fleming, who has been active in promoting the Pacific cable scheme, states that if the Australian colonies are ever to succeed in breaking down the present monopoly, the laying and working of the new line must be undertaken by the Governments interested, in place of a guarantee system. He points out one of the

possible contingencies of the future. Let us, by way of illustration, assume that a company is formed under a Government guarantee of gross traffic equal to £200,000 per annum for a period of 25 years. What, in this case, would prevent the existing company, and the new company, entering into a secret pooling agreement, by which it would be the policy of both to pass over the old line the great mass of the traffic, the object being to establish against the Governments each year of the 25 as large a claim as possible under the guarantee? I do not see that it would be possible to prevent the two companies amalgamating their interests in this or in some other way, and, as a consequence, a powerful monopoly would be built up to exact its own terms."

The Romance of Our News Supply.—The *Strand Magazine* for this month has an article under the above heading, in which much interesting information is given as to the means by which the world's news is gathered for the public. The writer also points out the various difficulties which are encountered and overcome. The following extract shows how slight are the causes to which interruptions or delays may sometimes be attributed:—"Perhaps no single telegraph system passes through such diverse countries as that of the Indo-European Telegraph Company. This line extends from London to Lowestoft; then it dips under the sea to Emden, on the German coast, whence it passes through Germany to the Russian frontier. From this point, the wire passes by way of Warsaw, Rowno, Odessa, the Caucasus, and Tiflis, to the confines of Persia, and again by Tauris to Teheran, where it joins the Indian Government line, which runs from the Persian capital to Bushire, on the Persian Gulf. From the last-named town wires run through Beloochistan, completing the route by connecting up at Kurrachee. This great line obviously has much to contend with. Flocks of wild geese fly against it on the snow-swept steppes of Russia; nomad tribes of the Caucasian districts make firewood of the poles; and the unscrupulous innkeepers of Georgia will deliberately cause faults in the wires, in order to create a boom in the post-horse trade."

As regards cables, the writer says: "I am assured that the cable between Land's End and Lisbon gives more trouble than any other, owing to the frequent breakages at such great depths as 3,000 fathoms. The Eastern maintenance bill, by the way, is between £80,000 and £100,000 a year."

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—July 24th. The Electric Committee invite tenders for the construction of street culverts, supply of C.I. pipes and frames, insulators, insulated cable, copper strip, &c. Particulars from the engineer at the Central Station, Chapel Lane.

Brighton.—The Council are wanting tenders for condensers, electrically driven air pumps, &c. Further details will be found among our advertisements.

Cowes.—August 27th. Tenders are invited for laying down electric lighting plant of sufficient capacity to supply at the same time 2,200 8-C.P. lamps, also public lighting and the laying of mains to accommodate 3,000 lamps. Details can be obtained from Mr. N. F. Dennis, engineer to the Council, Cowes.

Datchet (Berks.).—July 20th. The tenders for lighting the village of Datchet, for the Barker's Bridge House Trust, during October to March, with oil, gas, or electricity, must be in to-morrow.

France.—August 11th. The Municipal Authorities of Ille-sur-Tet (Pyrénees Orientales) are inviting tenders for the concession for the electric lighting of the town. Tenders should be directed to the Mairie d'Ille-sur-Tet (Pyrénees Orientales), France.

Holland.—July 26th. The Dutch Minister of the Waterstaat is inviting tenders for (1) the erection of and repairs to telegraph lines in Brabant, La Gueldre, and Le Lunbourg, and (2) between Harlem and Rotterdam. Tenders to the Minister of the Waterstaat, The Hague.

Holland.—August 9th.—The Minister of the Waterstaat at the Hague, is invitiug tenders for the construction of a new post and telegraph office in Amsterdam. Tenders to above.

London.—The London County Council will shortly be advertising for tenders in connection with the proposed electric lighting of the Victoria Embankment and Waterloo and Westminster Bridges. The sum to be spent is about £16,590.

Malta.—August 1st. The Crown Agents for the Colonies and the Receiver-General and Director of Contracts at Valletta, Malta, are inviting tenders for the supply of materials in connection with the installation of the electric light in the civil and war department buildings in Malta.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—July 29th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession for the construction and operation of an electric tramway along the main streets of the town.

Spain.—The Municipal Authorities of Biar (Alicanté province) are at present inviting tenders for the concession for the electric lighting of the town during a period of five years. Tenders to the Secretaria del Ayuntainiento, Biar (Alicanté).

Surbiton.—Six firms are to be invited to send in plans and specifications for electric lighting.

Wellington (Salop).—The Shropshire Iron Company are inviting tenders for electric lighting plant, forges, &c., &c. Further particulars will be found in our advertisement pages.

CLOSED.

Birkenhead.—Owing to the error which occurred in Messrs. Holme & Green's tender for erecting the generating station, the tender of Mr. John Shaw for the work for £4,900 has been accepted, notwithstanding the fact that it is higher than Messrs. Holme & Green's amended tender.

Hanley.—Messrs. Crompton & Co.'s tender for 30 arc lamps with cast iron pillars, for £539, has been accepted by the General Purposes Committee; also that of Mr. Cornes for the erection of additional buildings.

NOTES.

The Effects of Lightning in Ben Nevis Observatory.—In our issue of June 21st, we reported that Ben Nevis Laboratory had been struck by lightning. Mr. William S. Bruce, in last week's *Nature*, gives some interesting details regarding the occurrence. There have been previous flashes at the Observatory, but the most destructive was that of June 19th. It seems that repeated clicks on the telegraph instrument were heard, and shortly after there was a brilliant flash accompanied by a deafening roar. A pillar of smoke was discharged from the telegraph instrument and from the stove pipe, filling the room. Immediately after, a second but slighter discharge, happened, which hurled two boxes and a picture, that were in the vicinity of the lightning protector, across the kitchen, and blew off the button and outer casement of the electric bell in another room. The solder on the kitchen chimney outside, a copper fastening of the lightning conductor, and many portions of the telegraphic wire and apparatus were fused, and the woodwork of the Observatory was scorched in several places. A little later a small fire was discovered behind the panelling between the kitchen and the office, but this was soon overcome. The damage done to the telegraphic apparatus was serious, and from information supplied by the engineer to the Post Office Telegraphs it appeared that the lightning protector was very badly fused, the plates showing a patch of fusion as large as a sixpence. This saved the cable from serious damage. All connecting wires within the building were rendered useless. The majority were so heated as to melt the insulation off, and, in one or two cases, the copper conductors were melted by the discharge. In one case, the fusion set fire to the woodwork. The coils of Neale's sounder were fused and rendered useless. The keys suffered worst of all, the left pedal or "tapper" bearing the strongest evidence of the severity of the discharge. The back contact (platinum), the brass extension holding the same, and the steel spring (platinum-tipped) above, all being fused into one solid amalgam. The pillar, to which the zinc leading wire from the battery was connected, had a large patch of fusion near its base, and the front platinum contacts of the same (left-hand) pedal were consumed entirely. There were small traces of fusion on the right pedal, but of a trifling character. The line wire connected to the left-hand terminal of the coil had been fused close to the terminal. The interior of the instrument case was considerably blackened, as also the greater portion of the keys, the result of the "arc" caused by the discharge at the moment of fusion. The vacuum protector at Aslimtee, the base of the cable, also the plate protector in Fort William Post Office, were fused, but only slightly, the main discharge having expended itself on the summit. The Low Level Observatory instrument and protector were unimpaired, and communication between there and Fort William Post Office was carried on as usual after the removal of the fault in the Post Office protector. St. Elmo's fire was very strongly felt for several hours after.

Perpetual Motion.—We are favoured with a copy of what purports to be a specification, and drawings of a perpetual motion machine. The inventor, Mr. Gordon Earl Adams, proposes to couple an electric generator and motor, shaft to shaft, and after starting the motor by current from an accumulator, the motor drives the generator, and the generator in turn sends its current into the motor, and so will drive it on for ever. The inventor, however, does not seem to explain how he has disposed of the resistance of his copper coils, the hysteresis of his iron cores, and the friction in his bearings, and therefore we unhesitatingly say that this inventor, like all others who attempt perpetual motion, has left these consumers of energy out of his philosophy. In the specification he says: "Newton's laws of mechanics do not take velocity into account." Perhaps not, but it is needless arguing against the theories of anyone who believes perpetual motion possible. We may refer the inventor to Dr. Hopkinson's classical test with a motor and generator coupled together, the whole current of the generator going through the motor and driving it. In this case, so far from the combined machines running on perpetually, he required about 10 horse-power from a steam engine to keep them up to a fixed speed. This result was, of course, to be expected. It is a pity to see energy and money spent in pursuing perpetual motion. We had thought that with the *fin de siecle* spread of science and mechanics, the impossibility of perpetual motion was apparent to every schoolboy.

English or German Wire.—In the *Iron and Steel Trades Journal* for the 13th inst., we notice that Mr. A. J. Balfour visited the Bradford wire-works of Richard Johnson and Nephew, Manchester, and addressed the men. Mr. J. T. Johnson said the bulk of the wire made in England was in Lancashire, at Warrington, or at Bradford. He was sorry to say their trade was not improving, and a good deal of wire which ought to be made in England was made in Germany. When the Secretary of State for India required any wire, he put it down in his specifications that it must be of British manufacture; but the Postmaster-General did not. There was to be, sooner or later, a Pacific cable, and they in Bradford thought that the wire which bound Great Britain and her colonies together should not come from Germany, but from England. Such wire as the Postmaster-General had bought of English make had not even been the subject of tender from Lancashire makers for two years past; but for 18 months, at least, the late Postmaster-General had sanctioned the giving of the contract to a firm in Shropshire without any tender whatever. It should at least be some satisfaction to Mr. Johnson, says our contemporary, to know that although the Postmaster-General does not prohibit the use of German wire, a Shropshire works has been able to defy German competition.

The Smoke Annihilator Company.—Says the *Financial News* of Tuesday:—"In the presence of the three sad-looking shareholders, one of whom was a lady, the liquidator of the Smoke and Fumes Annihilator Company gave the final touch to the annihilation of that unfortunate venture. It came into existence in the middle of January last, and it went into voluntary liquidation in May, and during the brief, inglorious interim, it carried on no business, and did nothing except rent an office and employ a secretary at a salary of £3 a week; in fact, this much talked of company, which was to get rid of all our smoke and help to purify the atmosphere of our great cities, has, with a strange irony, itself ended in smoke, and the disappointed shareholders, instead of reaping a fruitful harvest of dividends, have to submit to the unpleasant experience of losing a proportion of the money they subscribed." Our contemporary further on deplores the fate of a man "devoting years and money to the perfection of a contrivance which, had it been put into general use, would unquestionably have been a great public boon, and the unfortunate result is that he cannot meet his engagements, and the patent remains practically unexploited," and concludes by sagely remarking that "the moral of it all is that it is not of much use looking to the public for financial aid unless there are evident commercial possibilities, apart from any mere hygienic advantages." *Sic transit gloria mundi.*

Niagara-Buffalo Transmission Scheme.—The technical Press of the United States seems about as divided and antagonistic as it is possible to be. Of late, it has been quite a relief to receive copies of our American exchanges in which there is not an interchange of abuse between editors. Two of our contemporaries are at present fencing over the Niagara-Buffalo transmission scheme, but this is a more legitimate subject for discussion than some which have been lately handled. One paper, writing on the subject, recently said:—

> It appears that the Niagara Power Company is willing to go to the large expenditure necessary to introduce Niagara power in the City of Buffalo. It is certain that the company cannot sell that power unless it can be used at a cost below that of steam-power, yet Buffalo does not seem to be willing to have the company, at its own cost, free of charge to the city, put Niagara electric power on sale in the City of Buffalo! . . . . The action of the city has given the impression to some people not familiar with the successful transmissions of electric power for greater distances than that between Niagara and Buffalo that there is some question about the practicability of this transmission. The fact that the Niagara Company is ready to instal the plant would be sufficient answer to this suggestion; but those who know of the Frankfort-Lauffen transmission of 108 miles, and the more recent successful operation of the various plants in this country, such as at Telluride, Sacramento, and other places where the distance exceeds 20 miles (as well as the Tivoli-Rome installation), recognise in this situation no reason for doubt of the entire success of the Niagara transmission to even greater distances. It is an instance of remarkable blindness to its own interests.

To these and other comments a very lively contemporary responds in columns of argumentative matter, and in a subsequent article, in the last issue to hand, says:—

> There is an old saying that there are none so blind as those who will not see. It makes no difference that we point out to our contemporary that *none* of the schemes mentioned as living examples of commercially successful transmission of 20 *miles* or *over* are equal to that distance, it "still ventures to hold" that they are. It makes no difference that the records show that at the Frankfort-Lauffen transmission the power cost five times as much when delivered at Frankfort as it could be generated locally for by steam—our contemporary "still ventures to hold" that it was a commercially successful experiment. . . . . Should the Niagara-Buffalo transmission scheme prove a commercial failure, as we are convinced it will, it will give the business of electrical transmission of power the blackest eye it has ever had. It will give it a set-back from which it will not recover for 20 years. If the scheme is to be a success, then those who have been projecting it these many years must have some figures upon which success can be based. Why don't they publish these figures? Why don't they state what advantages will accrue to Buffalo by the delivery of the power there?

In another article the same contemporary says:

> One of the most significant features of the meeting of the American Institute of Electrical Engineers at Niagara was the discussion following Dr. Emery's paper on the cost of steam power. Both the paper and the discussion were pertinent to the occasion, and substantiated most fully the position which we all along have maintained, viz., that it was extremely doubtful if the Niagara Power Company could sell power in Buffallo in competition with locally generated steam power.

Without attempting to join in the dispute, we would say that the Niagara Company may be trusted to look after its own interests. Time and practice alone can decide whether or not the scheme will be commercially successful, though of course our contemporary does well to record its suspicion as to the ultimate result.

Copper Sheathing Wires for a Submarine Cable.—*Nature* states that the sheathing wires of the submarine cables which carry electricity to the electric lamps of the spar buoys in New York harbour are made of hard-drawn copper. If this is so, we do not quite see the advantage of it, for the durability of copper in sea-water is questionable. It soon becomes covered with a green coating of oxychloride of copper, which peels off. It is this action which makes copper sheathing of such value for the bottoms of ships, as any barnacles which may adhere to the coating of oxychloride of copper naturally peel off with it.

The Commercial Cable Company.—This company, says the *Cable's Recorder*, is fully justified in claiming the premier position among Atlantic companies. It possesses the shortest and most reliable cables, and the time of transmission has been reduced to a minimum. This success can be attributed not a little to the splendid working staff, hailing chiefly from the British Postal Telegraph Service.

Annealing Armour Plates Electrically.—In a recent issue of the *Pacific Electrician*, Mr. W. W. Hanscom contributes an article on the process of annealing nickel steel armour plates by electricity. He shows that attempts made to locally anneal certain hard spots by means of the oxy-hydrogen blowpipe and other apparatus were unsuccessful, the only satisfactory method being the electrical one of the Thomson Welding Company, of Lynn, Mass. By all other means than electricity, it was found impossible to apply sufficient heat in a concentrated form to attain the desired results, as the large mass of metal surrounding conveyed the heat away very rapidly. One of the company's annealing equipments has recently been installed at some iron works in San Francisco, at which Mr. Hanscom is the chief electrician, for the purpose of annealing armour plates for a U.S. battle ship. The apparatus in general consists of a 40-kw. alternator, with its exciter, a regulating rheostat, a transformer annealer, and the engine for driving the same, the latter developing 55 H.P. at 450 revolutions. The alternator has six coils on as many pole pieces, the windings being in two series of three in multiple. The armature is of the toothed type, with six coils, connected in a multiple of three series of two. It is wound for an output of 135 ampères at 300 volts, when making 1,000 revolutions per minute. A pulley on the end of the armature shaft drives the exciter, a D type shunt wound generator of 100 volts, at 2,000 revolutions per minute. Its terminals are connected to alternator fields through the regulating rheostat, a cylindrical frame, having German silver coils cut into or out of circuit by a contact arm on top. The coils are protected from mechanical injury by the wire gauze covering, which arrangement permits of a constant circulation of air. The transformer annealer is of the shell type. In the operation of annealing, the contact pieces are brought up against the brightened surface of the plate and wedged into position, straddling the spot to be annealed, after the regular rheostat has been adjusted to a point reducing the primary current to a minimum. The distance between the contact pieces for a hole $\frac{7}{8}$ths of an inch in diameter is $1\frac{3}{4}$ inch. When the contact is established between contact pieces and the plate, a slight humming noise notifies the operator, and the primary current is gradually raised to its maximum. A bright red spot then appears under each contact piece. The intense local heat at these spots causes the plate to expand outwardly in the direction of least resistance, forming slight mounds, from which circles of a gradually changing colour slowly approach the centre. The primary is kept up till the plate has become sufficiently heated to char or even ignite a pine stick held against it, and is then gradually decreased, till it has again reached the minimum. The first or heating period requires about three minutes, during which the secondary current has reached from 3,500 to 6,000 ampères at 4 volts. The second or cooling period requires from 10 to 12 minutes, in order to permit the sudden chilling of the spot due to the surrounding mass of metal, and to insure a perfect anneal. The plate at the spot of annealing presents a dark blue colour, elliptical in shape, with a major axis of 4 inches and a minor axis of $2\frac{1}{2}$ inches, and is very readily drilled and tapped.

The "Cable's Recorder."—We are in receipt of No. 1 of this new monthly journal hailing from Valparaiso. The object of the *Cable's Recorder* is to bring all connected with the cable service into closer unity; for as many of the stations are isolated, the members of the staff are only in touch with their fellow operators by wire; therefore it is hoped that the gleanings of the outer cable world, to be found in the pages of our contemporary, will be welcome to them. We think the idea is distinctly a good one, and we hope the *Cable's Recorder* may receive general support, and achieve a legitimate and lasting success. This, however, will depend upon the operators themselves, who, we trust, will not lose the opportunity now presented of having a representative organ.

Technical Education.—A report just presented to the Plymouth City Council says that during the year an electrical and mechanical engineering shop has been added to the Technical Schools, and this, it was hoped, would advance the technical education of the town.

The Ocean Depths.—A correspondent draws our attention to the following paragraph, which appears on the cover of the second of a series of leaflets on Atlantic cables, which we mentioned in our issue of the week before last:—"The greatest known depth of the Sea is in the South Atlantic Ocean, midway between the Island of Tristan d'Acunha and the mouth of the Rio de la Plata. The bottom was there reached at a length of 40,236 feet, or $8\frac{3}{4}$ miles, exceeding, by more than 11,000 feet, the height of Mount Everest, the loftiest mountain in the world. In the North Atlantic Ocean, south of Newfoundland, soundings have been made to a depth of 4,580 fathoms, or 27,480 feet, while depths equalling 34,000 feet, or $6\frac{1}{2}$ miles, are reported south of the Bermuda Islands. The average depth of the Pacific Ocean between Japan and California is a little over 2,000 fathoms; between Chili and Sandwich Islands, 2,500 fathoms; and between Chili and New Zealand, 1,500 fathoms. The average depth of all the ocean is from 2,000 to 2,500 fathoms." There does not appear to be a single statement in the above which is not grossly incorrect. No such depth as 40,236 feet, or 6,806 fathoms, has ever been found in any part of the world, though, about a year ago, we remember seeing a statement in a newspaper to some such effect. On the authority of Admiral Wharton's paper, read at the last meeting of the British Association, the deepest sounding ever yet obtained is 4,655 fathoms, or 27,366 feet, at a position 110 miles outside the Kurile Islands, lying to the north of Japan. We know of no such depth as 4,580 fathoms south of Newfoundland, and there is certainly nothing like 34,000 feet, or 5,666 fathoms, south of Bermuda. There is, however, a depth of 4,561 fathoms about 90 miles north of San Juan de Porto Rico, which, we believe, is the third deepest sounding ever obtained. Surely, even in a leaflet published for advertising purposes, a little more accuracy is to be expected.

Electric Lighting and the Telephones at Cape Town.—The municipal electric lighting station at Cape Town has only recently been started; but the Colonial telegraph and telephone officials have already found that, under certain conditions, an electric light undertaking may be a very bad neighbour to a telephone exchange. The Government exchange is on the single wire system, with earth returns. It is therefore eminently calculated to suffer from the proximity of the electric lighting circuits, both by induction and conduction, if faulty conductors are in use. According to advices received from the Cape, troubles have apparently arisen in both ways. Induced currents on the telephone lines have dropped the indicators at the exchange, and rung the subscribers' bells in a wholesale fashion. Such operations, when carried out with lack of discrimination, cause an undue strain to be set up in the peaceful relations between the subscribers and the switch clerks. There have also been a number of instrument faults caused by the electric light wires coming into contact with the telephone wires. One bad case of the kind, due to a broken electric light wire falling across telephone wires, caused a fire on a section of the switchboard at the exchange. A number of instrument coils were more or less injured, and much more damage would undoubtedly have been done had not all the jacks been quickly disconnected, and all the wires that led to that section of the board been promptly ripped away.

The City and Guilds of London Institute Technological Examinations.—In the recent technological examinations in "Telegraphy and Telephony," at the above Institute, in the "ordinary" grade 89 candidates passed first class, and 48 second class. In the "honours" grade 30 candidates passed first class, and 13 second class. In "Electro-Metallurgy," in the ordinary grade 17 passed first, and 5 second. In the honours grade, 9 passed first, and 4 second.

Transformer Chambers.—Judging by what was said at Tuesday's meeting of the London County Council, there is to be another inquiry opened by the Board of Trade in regard to transformer chambers. The County Council will, of course, be represented, and present a host of objections.

Prize Offered.—The Royal Scottish Society of Arts has decided to offer for competition a Keith prize of £50 for improvements in electric energy meters for domestic supply. Competitors will be expected to submit, in addition to a descriptive paper, accompanied by detail drawings, a working meter adjusted for a mean pressure of 115 volts, and suitable for a house in which the minimum number of watts being taken at any time is 4,000. Special importance will be attached to the minimum load at which the meter can register correctly, and to the energy absorbed by the meter when the consumer is using a light load, or when no energy is being taken. Conditions of the competition were discussed and adjusted, and it was agreed that the award should be made during the session of 1896, the Society reserving the right to withhold the prize in the event of there being nothing deserving the award. Alternatively, the Society may award a smaller amount should anything meritorious, but not deserving the full prize, be sent in.

Correspondence.—Just as we go to press we have received a communication from Mr. A. G. New, on the subject of the I.E.S. battery. We regret we are compelled to hold it over until next week, owing to its late arrival.

NEW COMPANIES REGISTERED.

Amazon Telegraph Company, Limited (44,532).—This company was registered on July 5th with a capital of £250,000, in £10 shares, to acquire and carry out a concession from the Government of the United States of Brazil, dated April 29th, 1895, for the establishment and working of telegraphs in the States of Para and Amazonas, in Brazil, and to establish or acquire, construct, work and maintain electric telegraphs or telephones in the said States, or elsewhere in South America. The subscribers are:—W. S. Andrews, 18, Old Broad Street, E.C., chairman of company, 200 shares; R. H. Browne, Reigate, Surrey, director of company, 100 shares; J. Coppen, Ashford, director of company, 400 shares; D. H. Goodsall, 17, Devonshire Place, W., director of company, 200 shares; A. Wood, Abbey Wood, Kent, director of company, 500 shares; R. M. Cunningham, Blomfield House, E.C., secretary, 100 shares; E. S. Hodson, King Charles Road, Surbiton, accountant, one share. The number of directors is not to be less than three nor more than eight. The first are:—W. S. Andrews, Lord R. H. Browne, J. Coppen, C. W. Earle, D. H. Goodsall and M. A. Wood. Qualification £1,000; remuneration £1,500 per annum divisible. Registered office, Blomfield House, London Wall, E.C.

Galloways, Limited (44,604).—This company was registered on July 12th with a capital of £115,000 in £100 shares, to acquire the business carried on by a company of the same name, to enter into a certain agreement, and to carry on the business of engineers, boiler makers, iron and brass founders, rivet makers, millwrights, machine and engineering tool makers, contractors, metal workers, electricians, suppliers of electricity, consulting engineers, &c. The subscribers (with one share each) are:—C. J. Galloway, Thorneyholme, Knutsford, engineer; E. N. Galloway, Normanly, Altrincham, engineer; A. W. Galloway, Thorneyholme, Knutsford, engineer; J. H. Beckwith, Beechcroft, Bowdon, engineer; H. Bowman, Sandgate, St. Anne's-on-Sea, engineer; W. E. Norbury, West View, Chorlton-cum-Hardy, engineer; R. Mottram, Beechy House, Pendleton, engineer; C. Rought, 64, Cannon Street, E.C., engineer. The number of directors is not to be less than three nor more than seven; the first are J. Galloway, C. J. Galloway, E. N. Galloway, A. W. Galloway, J. H. Beckwith, W. E. Norbury, and C. Rought; qualification, 10 shares; remuneration of ordinary directors £50 each per annum. The following are managing directors:—C. J. Galloway (£1,000 per annum), E. N. Galloway (£1,250 per annum), A. W. Galloway (£750 per annum), and J. H. Beckwith (£750 per annum). Registered by C. Doubble, 14, Serjeant's Inn, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Denison Auto-Telegraph Machine Syndicate, Limited (40,327).—The statutory return of this company was filed on May 29th. The capital is £1,000, in £50 shares; 16 have been taken up, and eight issued as fully-paid; £50 per share has been called on the rest, and £275 has been paid, leaving £125 unpaid.

Acme and Immisch Electric Works, Limited (40,125).—The registered office of this company has been removed from Queen Street Chambers, Queen Street, Cheapside, London, E.C., to Dashwood House, 9, New Broad Street, E.C.

Baily, Grundy & Barrett, Limited (38,004).—The annual return of this company was filed on June 6th. The capital is £10,000, in £5 shares, and 662 have been taken up; £5 per share has been called, and £3,300 has been paid, leaving £10 unpaid.

Automatic Electric Railway Signal Company, Limited (37,636).—The annual return of this company was filed on May 17th. The capital is £10,000 in £1 shares. 5,940 shares have been taken up, and 4,300 have been issued as fully paid. £1 per share has been called on the rest, and £1,616 5s. has been paid, leaving £31 5s. unpaid. 10s. per share has been paid on 15 forfeited shares.

Benham & Froud, Limited (21,445).—The annual return of this company was filed on May 15th. The capital is £50,000 in £10 shares, of which 2,907 have been taken up. £10 per share has been called, and £28,982 10s. paid, leaving £87 10s. unpaid.

Browett, Lindley & Company, Limited (32,534).—The annual return of this company was filed on June 21st. The capital is £20,000, in £10 shares (1,600 ordinary and 400 preference); 1,362 ordinary and 200 preference have been taken up, and 800 have been issued as fully-paid. The full amount has been called and paid on the remaining 762 shares.

Andrews's Foreign Syndicate, Limited (42,854).—This company's annual return was filed on May 13th. The capital is £4,000, in £1 shares, and 3,710 have been taken up; 3,318 have been issued as fully-paid, and £1 per share has been called on the rest; £385 has been paid, leaving £7 in arrears.

Alliance Meter Company, Limited (43,295).—This company's statutory return was filed on June 26th. The capital is £5,000 in £1 shares, and 2,007 have been taken up. 2,000 have been issued as fully paid, and nothing has been paid on the rest.

Eastern Extension, Australasia, and China Telegraph Company, Limited (7,224).—The annual return of this company was filed on May 22nd; 250,000 shares have been taken up out of a capital of £3,000,000, in £10 shares, and the full amount has been called and paid.

China and Japan Telegraph Company, Limited (17,831).—The annual return of this company was filed on May 29th. The capital is £20,000, in £1 shares, and 14,761 have been taken up and issued as fully-paid.

Evered & Company, Limited (20,158).—This company's return was filed on April 18th; 16,496 shares have been taken up out of a capital of £200,000, in £10 shares; £10 per share has been called on 6,744, and £7 per share on 9,752, and £135,704 has been paid.

Electric Wiring and Fittings Company, Limited (29,676).—This company's annual return was filed on June 27th. 1,382 shares have been taken up out of a capital of £5,000 in £1 shares, and the full amount, except £7, has been paid.

Cuttriss, Wallis & Co., Limited (33,857).—The annual return of this company was filed on May 11th. The capital is £10,000 in £5 shares. 651 have been taken up, and 300 are considered as paid. £5 per share has been called and paid on 351 shares.

Electric Lighting and General Development Syndicate, Limited (36,048).—The registered office of this concern was, by notice filed May 10th, removed from 5, Queen Victoria Street, London, E.C., to 12, Harp Lane, London, E.C.

Canterbury Electricity Supply Company, Limited (39,780).—This company's return for 1894 was filed on June 5th. Seven shares have been taken up out of a capital of £50,000, in £5 shares, and nothing has been called.

CITY NOTES.

The Chili Telephone Company, Limited.

The directors' annual report states that a small addition to the tariff made in October caused some subscribers to withdraw, but others have been connected, making the aggregate number at all centres 4,015 at the end of the year, as compared with 3,987 at the beginning, or a gain of 28 for the year. The gross revenue from all sources for the past year compares favourably with that of the previous one; in 1894-5 it was $555,551; in 1893-4 it was $504,188; an increase of $51,363. Owing to the additional expense incurred by reconstructing some of the trunk lines which were in bad condition, the expenditure in Chili during the year has been exceptional. In 1894-5 it was $364,477; in the previous year $324,536, an increase of $39,941. The net income in Chili from all sources was: in 1894-5, $191,074; in 1893-4, $179,652, an increase of $11,422. The average rate of exchange for the year was 13·61d., as compared with 13·96d. in the previous year, giving a fall for the year of 0·35d. Converted into sterling at these rates, the figures given in the preceding paragraph are: in 1894-5, £10,835; in 1893-4, £10,448, an increase of £387. The liquid assets and liabilities in Chili on March 31st, 1895, were valued at 16⅜d., the current rate of exchange on that day, as compared with 13d. at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili, due to this rise in Exchange, amounts to £2,751, which has been carried to the reserve fund, raising it to £11,852. The expenditure in London is £116 less than in the previous year. The net profit of the whole business was: In 1894-5, £6,013; in 1893-4, £3,528; an increase of £2,485. The directors recommend the payment of a dividend of 2s. 6d. per

share, being at the rate of 2½ per cent. per annum, free of income tax, leaving £513 6s. 11d. to be carried forward to next year's account. During the year, the capital outlay in sterling was £3,845, and the total mileage was:—On March 31st, 1895, 6,420 miles 80 yards; on March 31st, 1894, 6,169 miles 432 yards; an increase of 250 miles 1,408 yards. The general manager in Chili reports that the prospects of the company are encouraging, and our affairs improving in every direction. It is with much regret that the directors report the death of their esteemed colleague, Mr. Thomas Greenwood, who devoted much of his valuable time and abilities in furthering the interests of the company since its formation. Mr. George Keith, who was for some time associated with the deceased gentleman in telegraph business, has joined the board, and has been elected its chairman. In accordance with the articles of association, Mr. Frank W. Jones retires from the board of directors, and, being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

The West African Telegraph Company, Limited.

The report and accounts for the year ended December 31st, 1894, to be presented to the tenth ordinary general meeting, to be held at Winchester House, 50, Old Broad Street, London, E.C., on Thursday, July 25th, 1895, at 2.30 p.m., states that the company's revenue for that period amounted to £64,761 5s., against which £17,286 18s. 6d. is charged for ordinary expenses, and £13,473 9s. 2d. for expenditure relating to repairs of cables, &c. After providing £916 5s. 3d. for income-tax and £26 11s. 3d. due to revaluation of currency assets, there remains a balance of £33,058 0s. 10d. From this balance there have been deducted £11,900 5s. 10d. for interest on debentures, and £11,766 13s. 4d. for sinking fund, leaving £9,391 1s. 8d., which has been carried to the general reserve fund. We record, with regret, the decease of our colleague, Mr. Thomas Fuller. The vacancy thus created has been filled by the election of the Hon. A. G. Brodrick. The directors who retire by rotation are Robert Kaye Gray, Esq., and the Hon. A. G. Brodrick, who, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

The following notice accompanies the report:—

In the accompanying report for 1894 it will be seen that the sum of £9,391, net revenue on the year's working, has been placed to the credit of the reserve fund. This is simply replacing the amount taken from this fund last year on account of heavy repairs. We are now in a sound financial position. With respect to the year 1895, the result of the first six months' working justifies your directors in paying an interim dividend of 2s. per share, which is at the rate of 2 per cent. per annum, and will be payable on the 26th inst.

The Yorkshire House-to-House Electricity Company, Limited.

The following notice has been issued to the shareholders:—

In view of the increasing demand for electricity in the City of Leeds, the directors have decided upon a considerable extension of the company's plant and buildings to meet the anticipated requirements for the winter of 1896. The existing buildings being now filled with plant, the directors are considering plans for a new engine and boiler house on the remaining land of the company, and propose to instal, in the first instance, additional plant of at least 1,000 indicated horse-power. These extensions will involve a large expenditure, and the directors have therefore decided to raise the required capital by the issue of shares unallotted. The 9,900 ordinary shares still unissued are now offered at par to the shareholders, who may apply for any number not exceeding their present holdings respectively. Should any shares remain unapplied for, they may be disposed of as the directors determine. A deposit of 10s. per share is payable on application, and a further sum of 10s. per share on allotment. No further call will be made payable before January 1st, 1896. Subsequent calls will not be made at intervals of less than three months, and no call will exceed £1 per share. As the company's ordinary shares have been recently dealt in at a premium, shareholders making application will obtain the advantage of any increase in the market value. Forms of application and copies of the original prospectus may be obtained from the secretary. The contracts and documents referred to in the prospectus may be inspected at the offices of the company. Applicants for shares will be considered to have notice of any other contracts, and to have waived further compliance with Section 38 of the Companies Act, 1867, and allotments will only be made on this footing. Applications for shares must be made on the printed form, and sent, with the deposit of 10s. per share, to the company's bankers, Messrs. Wm. Wms. Brown & Co., Commercial Street, Leeds, on or before Thursday, August 1st, 1895.

National Telephone Company, Limited.

The report of this company for the half-year ending June 30th states that the income accrued amounted to £393,855, as compared with £359,891 for the corresponding period of 1894, an increase of £33,964. The working expenses were £206,838, as compared with £187,089, an increase of £19,799. The net result, after deducting the Post Office royalties amounting to £35,264, is a profit balance of £151,703, as compared with £140,533, an increase of £11,170. The rentals carried forward for unexpired terms of running contracts amount to £390,978, as compared with £345,359, an increase of £45,619. Out of the available balance of £122,768 the board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income-tax, on the first and second preference, 5 per cent. per annum, less tax, on the third preference, and 5 per cent. per annum, free of tax, on the ordinary shares. The board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £3,289. The draft of the formal agreement with the Post Office, for the acquisition by the department of the company's trunk lines, having been laid upon the table of the House of Commons in accordance with the promise of the Postmaster-General, the preliminary agreement, requisite to give effect to the arrangements, was duly executed and completed on March 15th. The difficult and somewhat complicated details connected with the transfer of the lines are approaching completion, and payment of the purchase money, now in process of being ascertained, may be expected shortly. A Parliamentary Committee on telephone questions has had during the past session many sittings and taken much evidence, but has not made a final report. The inquiry stands over till the new Parliament assembles, when it may be hoped the questions submitted to the committee will be speedily determined.

The City of London Electric Lighting Company, Limited.—The directors have declared an interim dividend on the preference shares of the company at the rate of 6 per cent. per annum for the six months ended June 30th last. The dividend to be payable on and after the 25th inst. The returns are as follows:—Gross revenue return, quarter ended June, 1895—Revenue from sale of current for public lighting, quarter ended June, 1895, £3,501; corresponding quarter last year, £3,162; revenue from sale of current for private lighting, &c., quarter ended June, 1895, £12,283; corresponding quarter last year, £7,153; estimated revenue from other sources, quarter ended June, 1895, £200; total, quarter ended June, 1895, £15,984; corresponding quarter last year, £10,315; increase, £5,669; equivalent of 8 C.P. lamps connected on June, 1895, 159,250; increase during quarter, 10,656; equivalent of 8 C.P. lamps connected on June, 1894, 99,140; increase during corresponding quarter last year, 15,927.

Eastern Telegraph Company, Limited.—The directors announce that, subject to final audit, the accounts show after placing about £100,000 to reserve, a balance available sufficient to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, less income-tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of tax, on the ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ending March 31st.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—City of London Electric Lighting Company, Limited, further issue of £200,000 5 per cent. debenture stock, in lieu of the provisional certificates now quoted; Tramways Electrical Traction Company, Limited, 15,000 preference shares, Nos. 1 to 15,000, in lieu of the shares of the Tramways Company of France, Limited, now quoted.

Anglo-American Telegraph Company, Limited.—After placing £6,000 to the credit of the renewal fund, the directors have declared interim dividends for the quarter ended June 30th of 11s. per cent. on the ordinary stock, and £1 2s. per cent. on the preferred stock, payable on August 1st.

City and South London Railway.—The dividend for the past half-year is declared at the rate of 1½ per cent. per annum, with £965 carried forward. For the corresponding period last year the distribution was at the rate of 1 per cent. per annum, while £1,335 was carried forward.

St. James's and Pall Mall Electric Light Company, Limited.—The directors have declared an interim dividend for the half-year ending June 30th at the rate of 7 per cent. per annum on the preference, and at the rate of 4 per cent. per annum on the ordinary shares.

Electric Organ Company, Limited.—The letters of allotment in the Electric Organ Company, Limited (Hope-Jones system), have been posted.

Telegraph Construction and Maintenance Company, Limited.—The board has declared an interim dividend of 12s. per share.

Amazon Telegraph Company, Limited.—The letters of allotment have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 14th, 1895, amounted to £848; week ending July 15th, 1894, £882; decrease, £34; total receipts for half-year, 1895, £1,763; corresponding period, 1894, £1,761; increase, £2.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending July 14th, 1895, amounted to £1,186; corresponding week last year, £905; increase £281.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,356.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation July 10th.	Closing Quotation, July 17th.	Business done during week ended July 17th, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	103¾	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	47 — 49	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88 — 89	88½ — 89½	89¼	88
2,993,560£	Do. do. Defd.	Stock	...	...	...	8½ — 8¾	8½ — 8¾	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13½ — 13¾	13½ — 14	13 13/16	13⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	110 —114	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½ %	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	4⅛	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾ — 10¼	9¾ — 10¼	...	...
30,000£	Do. do. 4½ % Debs Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106%	103 —106 xd	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅞% §	2 %	9¼ — 9⅝	9¼ — 9⅝	9⅝	9¼
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16⅝ — 16¾	16¾ — 17	16 15/16	16⅝
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17½ — 18	17½ — 18	17⅝	17⅜
402,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —127	125 —128	126¼	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17¼ — 17½	17¼ — 17½	17⅜	17⅛
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106 xd	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106 xd	..	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —127	126 —129	126½	126
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —106	102 —106 xd	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114%	112 —115	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	10⅛ — 10⅜	10⅛ — 10⅜	10⅜	10 1/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17¼	17 — 17¼	17 1/16	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21⅜ — 22¼	21⅜ — 22¼xd	22⅜	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	49 — 52	49 — 52	51½	50
37,548	London Platino-Brasilian Teleg., Ltd.	10	2 %	2½%	1¼%	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	6 %	106 —110	107 —111	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000	5	*nil*	4 %	...	1½ — 2½	1½ — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅜ — 6	5⅜ — 6⅛	6⅛	5 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 17	16 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14½ — 15½	15 — 16	15⅝	15¼
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	5⅞ — 6⅛	5⅞ — 6⅛	6⅛	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107	105 —107 xd	106	105⅜
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109	107 —110	107½	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½ — 4½	3½ — 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	123 —128	126¾	125
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½ — 3	2½ — 3	2⅝	2 11/16
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97 xd	93¾	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	4½ - 5½	6½ — 5½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	104 —107	105½	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½ — 2½	1½ — 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	99 —104	101	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	11 — 11½	10¾ — 11¼	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¼ — 6⅝	6½ — 7	6⅝	6⅝
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4½ — 5	4½ — 5	4 3/16	4⅜
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	104 —108	104 —108	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	104 —108	104 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	7/16%	⅛%	⅜ — 1	⅜ — 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	9¾ — 10¼	10 — 10½	10 5/16	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	109 —111	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5¼ — 5⅜	5¼ — 5⅜	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	15 — 16	14½ — 15½	15½	15
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	16½	...
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	132¾	132
200,000	Do. Prov. Certs. all pd. (iss. at £28 pm. all pd.)	...	...	...	...	131 —134	131 —134 xd	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	9 — 10	9 — 10	10⅛	10 1/16
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6 — 6½	6 — 6½	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅜ — 7⅞	7⅜ — 7⅞xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10½ — 11	10½ — 11	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	115 —117 xd	116 —119	116⅛	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 8¾	8½ — 8¾	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼ — 8¾	8 — 8½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	9½	...
59,900	Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅞ — 8¼	7¾ — 8¼	8 3/16	...
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	7½ — 8	7½ — 8	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894	Closing Quotation, July 10th.	Closing Quotation, July 17th.	Business done during week ended July 17th, 1895. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2¼ — 2⅜	2¼ — 2⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2¼ — 2⅜	2⅛ — 2⅜	2 5/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	42 — 44	42 — 44	43	42½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	..	2 — 2½	2 — 2½	..	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	...	1⅞ — 2¼	1⅞ — 2¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	...	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	¾ — 1	⅝ — ⅞	½	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1¾ — 2¼	2 — 2½	2 1/16	1⅞
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1 — 1¼	⅞ — 1⅛	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1 — 1¼	1 — 1¼	1 1/16	1⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
7,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10½ — 11½	10½ — 11½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	14 — 15	14 — 15	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	..	...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	20 — 22	19 — 20	20⅝	19⅝
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	10 — 10½	10 7/16 — 10 9/16	...	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14⅜ — 15¼	15¼ — 15⅜	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44⅞	43½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107 xd	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 4⅝	4⅜ — 4⅝	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Chelsea Electricity Supply Ord., 6⅜—7¼.
Do. do. do. Pref., 7—7¼.
Electric Construction Corporation, 6 % Debentures, 85—90.
House-to-House Company (£5 paid), 4—4½.
Do. do. 7 % Preference, of £5, 7⅜—8¼.
Do. do. 4½% Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7½—8.
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5½—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE DESIG OF TRANSFORMERS.

By GEORGE ADAMS.

Transformer design is a subject which offers considerable scope for the skill of the electrical engineer. The subject being a large one, this article will be confined to those transformers having a closed magnetic circuit, and to be connected in parallel on constant potential mains. This type of transformer is by far the most frequently met with in practice; open circuit transformers, and transformers for constant current or series work, being a very small class, destined probably to become smaller.

The design of a successful transformer involves a number of considerations, and the combination of several conflicting principles. The assembling of not only electrical and magnetic, but also commercial facts into a symmetrical whole is dependent in a great measure upon the judgment of the designer. It is true he is guided to a certain extent by certain principles which have been established by mathematical investigation and physical experiment; but such data is not at present very plentiful, and that which is extant must frequently be modified by practical requirements—workshop and commercial considerations.

To begin with, it is necessary to know the position the transformer is to occupy when in operation; whether the transformer is to be a large or small one; in other words, Is the transformer to supply a large area, and occupy a substation, or to supply a few, say, six or eight houses?

For reasons that will be given further on, a large transformer has usually more copper in proportion to its output than a small one, and is consequently more expensive in proportion to its output than a small one. Having settled this point, the question as to the best proportion of iron to copper must be considered.

If the only consideration were efficiency the problem would be readily solved, for by putting plenty of copper in the transformer, that is to say by employing a considerable number of primary and secondary turns, the iron loss may be reduced, and the iron loss is the chief source of loss in transformers.

But for commercial reasons it is desirable to reduce the quantity of copper used to a minimum, otherwise the capital outlay over a large installation would be unreasonably large.

In practice, a compromise is arrived at, with the result that the modern transformer, for small sizes at any rate, is not an ideally perfect apparatus so far as regards efficiency; on the other hand, the transformer is less costly than it would be if perfect in this respect. Commercial reasons have also been instrumental in defining the form of the transformer and the class of material employed in its construction. Thus cores of wrought-iron wire and strip have given place almost universally to cores made up of sheet-iron stampings, because transformers are easily built up in the workshop by the latter method and the cost of workmanship is reduced accordingly.

Another important point in practice is accessibility for repairs. Makers do not appear to have given sufficient prominence to this item. Great care is usually taken in the process of manufacture by thoroughly insulating the primary and secondary coils to prevent any danger of the insulation breaking down; but if, unfortunately, this should happen there are no means provided for readily examining and making good the insulation without dismantling the whole of the transformer, that is to say without taking off each plate of iron, one by one, until the coils are bare, then repairing the insulation and rebuilding the transformer. This is necessarily a tedious and costly process. Some makers have

no doubt experienced this trouble. Transformers have recently been designed by Mr. Kapp and the Oerlikon Company with iron cores, somewhat as delineated in fig. 1, in which access to the primary and secondary coils is readily obtained at the expense of very little time and labour. In the case of larger transformers some of the foregoing statements must be qualified, and greater prominence must be given in the design, to efficiency, and less to first cost.

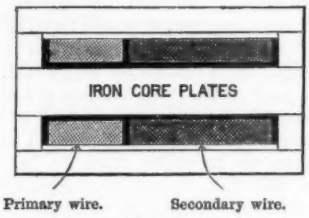


Fig. 1.

In all cases, however, it is of great importance to keep down the current on open secondary circuit, as this current represents a complete waste of energy. If the open circuit current is to be small the iron losses must be small, and this involves working at a low induction, using a good quality of iron for the stampings, providing a short magnetic circuit and a large number of primary turns.

In order to illustrate these principles a worked out example will be useful. Take the case of a 10 kilowatt transformer to transform from 2,000 to 100 volts, the frequency being 100.

The Mordey transformer is a simple and efficient construction, and will answer our purpose as an example. In this type of transformer, the core is built up of sheet-iron stampings about ·014 inch thick, each sheet being insulated from its neighbour by a sheet of thin paper. The stampings are made of such dimensions that the inner portion, the shaded portion in fig. 2, is used for building up the core in

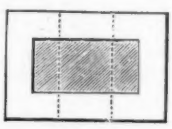


Fig. 2.

the complete transformer, being placed, when cut out, as shown by the dotted lines. By this form of stamping very little iron scrap is made in the process of manufacture; but it is questionable whether other important points are not sacrificed in order to obtain this supposed advantage.

Fig. 3 shows an outline plan and section of the transformer; but without the cast-iron box in which it is placed

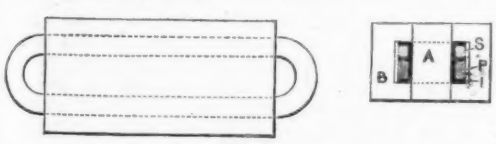


Fig. 3.

when in operation; as this portion does not, however, enter into the electrical calculations it is omitted in the figure.

We start with the condition that the losses in the copper circuits are not to exceed 1·4 per cent. of the total output. It is found in practice that the copper losses cannot be reduced much below 1·4 per cent.

The copper losses will then amount to

$$10{,}000 \times \frac{1{\cdot}4}{100} = 140 \text{ watts.}$$

Primary current at full load

$$= \frac{10{,}000}{2{,}000} = 5 \text{ ampères.}$$

Secondary current at full load

$$= \frac{10{,}000}{100} = 100 \text{ ampères.}$$

At full load the total rate of dissipation of energy in the copper circuits is

$$W = c_1^2 R_1 + c_2^2 R_2. \qquad (1)$$

But

$$R_1 = \rho \frac{l_1}{a_1} \text{ and } R_2 = \rho \frac{l_2}{a_2}.$$

Where ρ = the specific resistance per cubic inch of copper at 0° C., or the resistance of one cubic inch across opposite faces,

ρ = ·00000064 ohms at 0° C.

a = area of cross section of wire in square inches, l_1 and l_2 = lengths of primary and secondary wires in inches.

c_1 and c_2 = currents in primary and secondary.

R_1 and R_2 = resistances of primary and secondary.

Substituting in equation (1) we get

$$W = \frac{c_1}{a_1} \rho\, c_1\, l_1 + \frac{c_2}{a_2} \rho\, c_2\, l_2. \qquad (2)$$

If we allow for increase of resistance due to temperature, at a temperature of 25° C. or 77° F., ρ becomes ·000000703 ohms. This is a rise of about 17° F. above the normal temperature.

Now $\frac{c_1}{a_1}$ and $\frac{c_2}{a_2}$ are the current densities in the two wires. The current density should not be greater than 900 ampères in this transformer if the coils are to be cool in operation.

Then

$$\frac{c_1}{a_1} = \frac{c_2}{a_2} = 900$$

and equation (2) becomes

$$W = 900 \times {\cdot}000000703\,(c_1 l_1 + c_2 l_2) \qquad (3)$$

But in practice, $c_1 l_1$ will be nearly equal to $c_2 l_2$, and we have

$$W = 1{,}800 \times {\cdot}000000703\, c_1 l_1$$

$$\therefore l_1 = \frac{W}{c_1} \times \frac{1}{1{,}800 \times {\cdot}000000703} \qquad (4)$$

$$a_1 = \frac{c_1}{900} \qquad (5)$$

$$R_1 = {\cdot}000000703 \frac{l_1}{a_1} \qquad (6)$$

Filling in values,

$$l_1 = \frac{140}{5} \times \frac{1}{1{,}800 \times {\cdot}000000703} = 22{,}047$$

inches = 1,838 feet.

The primary wire must carry 5 ampères ∴ area of wire $= \frac{5}{900} = {\cdot}00555$.

No. 14 B.W.G. wire, ·083 diameter bare, ·103 covered, will fulfil this condition.

Resistance of primary wire,

$$R_1 = {\cdot}000000703 \times \frac{22{,}047}{{\cdot}0055} = 2{\cdot}8 \text{ ohms.}$$

Having found the length, area, and resistance of the primary wire, we proceed to fix the dimensions of the iron core.

The relation between total flux, F, and electromotive force is given by the formula,

$e_1 = 4{\cdot}45\, F\, t, n\, 10^{-8} = \sqrt{2}\, \pi\, F\, t\, n\, 10^{-8}$, where e_1 = primary volts ($\sqrt{\text{mean square}}$ or effective values.)

F = total flux.

n = frequency, or cycles per second.

t_1 = turns of primary wire.

$$\therefore \quad F = \frac{e_1 \times 10^8}{4{\cdot}45\, t_1\, n} \qquad (7)$$

But before we can use this formula we must decide upon the number of turns of wire to be employed. In practice, the number of secondary turns for a transformer of this ratio, namely, 2,000 volts to 100 volts, varies from about 12 to 50; a number which gives fairly good results is 24 turns on the secondary. With 30 to 50 turns of secondary wire, the transformer will have great efficiency; but the cost of copper will also be considerable.

(To be continued.)

GAS AND ELECTRIC HEATING.

By H. J. DOWSING, M.I.E.E.

At a recent meeting of the Société Technique de l'Industrie du Gas, of France, M. G. Perthius read a paper on "The Cost of Heating by Electricity." This paper is interesting as showing that electric heating has become of sufficient importance to warrant gas engineers spending their time in denouncing it, and endeavouring to prove that electric heating is more costly than gas. Any electrical engineer will acknowledge that a unit of heat produced by electricity at the present charge for current is more costly than that produced by gas, and it is merely flogging a dead horse to endeavour to prove it. The question, however, is not how much does it cost to produce a unit of heat, but *how much of it can you use?* We may, for instance, have any amount of cheap power in the waves of the sea, but how much of it can we employ for practical purposes? It is usually found more profitable to employ steam engine, and pay for every foot-pound produced, rather than to attempt to use wind-power—not only on account of its unreliability, but largely on account of the uneconomical means we have to employ for its utilisation. This line of argument should appeal especially to gas engineers, for they entirely depend upon it to prove the economy of gas as a heating agent. M. G. Perthius, in his paper, said that he thought it necessary to throw some light on the subject of the cost of heating by electricity, owing to the sensational articles that were being published, and goes on to state that "whatever might be the source of electricity, its high cost made its practical adoption impossible." Has M. G. Perthius ever heard of electricity produced by water-power? Does he really think that gas, or any other fuel, will produce heat cheaper than can be produced by this means? I know of a large mill driven by water-power where some £700 a year is spent for fuel to maintain the heat necessary for the particular manufacture carried on. The millowners are now about to utilise more water-power, which costs them practically nothing, and warm their mill by electricity. Besides obtaining heat at a very low cost, they will have the advantage of being able to regulate the temperature better than by any other means. In works with ample steam-power, electrical heating can often be produced cheaply, and in large houses with private plants, electric heating can be obtained, especially during the day when it is most required, at as low a cost as by other suitable means. M. G. Perthius bases his comparisons, however, on the very safe grounds of the supply companies' charges, which are well known to be a long way off their lowest point. In order to make a comparison, the writer of the paper takes the cost of heating a ton of water by gas and electricity. Now most people are satisfied to take the cost of heating a pint of water, or at most a gallon, especially as few private houses require *tons* of water heated per day. We are told that with electricity at 5¾d. per unit, it would cost 6·3d. to produce heat sufficient to raise a *ton* of water 1° Centigrade, while with gas at 6s. 8d., it would only cost ½d. It would have been interesting if M. G. Perthius had carried his calculations a little farther, and added the information that with coal at 25s. per ton, the same amount of heat would come to *one twenty-fourth* the cost of gas. With such figures only before us, it would seem surprising that anyone should dream of using *even gas* for heating purposes. One thousand cubic feet of gas at its highest calorific value (696 units per cubic foot) will produce no more heat units than 55 lbs. of coal. Gas cost, say, 3s., and coal 7d. Why then is gas used for heating at all? *Certainly not because the heat is produced at a cheaper rate*, and this knowledge no doubt accounts for the delay in the gas companies taking up heating and cooking in the first instance. Luckily for the manufacturers of gas stoves (and the gas companies themselves), electric lighting came along and gave the desired impulse. Probably a similar period of incubation is going on in the minds of the directors of electric supply companies at the present time, and some kindly opposition is required to hasten the process. It does seem strange that, with the gas companies' experience before them, smart business men should allow hundreds of horse-power to be dissipated daily without a strenuous effort to dispose of it in a field which is illimitable. Interest on the many thousands of pounds representing the cost of a central station must be earned (together with all costs of working) by the average demand of less than two hours per day. Most companies manage to pay a dividend on this two hours' demand, and if only another two hours' demand could be obtained *at another part of the day*, a double income on the same capital expenditure would be assured. The cost of interest depreciation management, and the fixed charges generally, are covered daily by the price per unit charged for lighting. This is acknowledged in Wright's system of charging, and any subsequent demand for current is charged at half rate. An equitable system would be to allow consumers the privilege of using up to their maximum demand during the day at a slight extra charge on works cost. A customer having already paid in the price charged per unit for light, a sum representing interest and fixed charges on the amount of machinery necessary to produce the current required, ought not in all fairness to be called upon to pay these charges over again on that day, because he happens to require the current at another time for another purpose. If these matters are taken into consideration, the price charged per unit for "extra" uses would be so low as to, in many cases, approximate the cost of gas.

The reason that more expensive methods of heating than coal may sometimes be used with economy depends, as above stated, as much upon the heat utilised as on the cost per unit to produce. Thus, with our English custom of heating by means of an open fire, 90 per cent. or more of the heat produced from coal is usually wasted, but in the most efficient forms of gas heating apparatus 60 or 70 per cent. may be utilised. This at once shows that the disparity as to cost is not so great as at first sight appears. Add to this the greater convenience and cleanliness, and we see at once why gas may be sometimes used with comparative economy. There is not so great a difference in the cost of heat produced by electricity and gas, as between gas and coal, and when it is remembered that electrical heating apparatus is in many cases far more efficient than either coal or gas, we see that there is a possibility of using it, although the heat unit may be more costly to produce. The electrical system of heating has more advantages over gas than gas over coal. Not only is the electrical system more convenient than gas in being more portable, but it is even more cleanly, for there is an entire absence of combustion. The objectionable smell of gas which in some cases entirely prevents its use is one of the penalties which has to be paid for convenience, but there is no such drawback with electricity. Danger of explosion there is none, and an almost entire absence of danger from fire. Are not these advantages well worth paying for? While the cost of electric heating is more than gas, electricity is steadily replacing the more expensive systems of producing heat as, for instance, the spirit lamp.

With electricity and gas at their present prices, I should recommend no one to use either system for boiling large quantities of water such as are required for household purposes. The only really economical way is to use a separate tubular boiler with coal or coke as fuel. If this system is adopted, all cooking operations can be carried on by electricity with advantage. For cooking purposes far less heat is required than is generally supposed. In a trial with a gas oven, it was found that out of a total of over 13,000 heat units required in roasting a joint of 8½ lbs., only 2,203 units were actually used in the food itself, the altogether disproportionate amount of 11,000 heat units being dispersed wastefully. Thus out of a total of 22 cubic feet of gas burned, only 3½ cubic feet were used in cooking the food, or, say, 16 per cent. When it is remembered that the oven is one of the most economical systems of cooking by gas, and more efficient than cooking by coal, it ought not to be a difficult thing for electricity to compete, despite its higher present cost.

Electricity must be compared with gas in the same manner as gas is compared with coal, *i.e.*, its efficiency and advantages must be taken into account. I no more expect that electricity will supersede gas for every heating purpose, than I believe gas will ever supersede coal as a fuel. Each system will have its place, and electricity will be used (as gas is now) where its greater advantages are valued, and not because it is always cheaper to use.

With the extravagant ideas at present abroad as to the amount of heat required for cooking purposes—based, no

doubt, on the wasteful systems now in vogue—it may probably surprise many to know that the energy used in a 16 C.P. lamp for one hour would nearly suffice to cook a pound of meat. Of course, the heat would be used, say, in a quarter of an hour, but the energy would be the same.

In criticising the paper above referred to, one of the speakers stated that, in his experience, you could do the cooking by any ordinary system while waiting for the heat to be generated by electricity! This is arrant nonsense. The rate at which the heat is generated depends entirely on the amount of energy used. Heat is generated immediately the current is turned on, and because the makers of electrical cooking apparatus usually find it necessary to make the current small in order to use the existing house wires, it is no reason why a much quicker system should not be employed. Has M. Henri ever seen an electric fry-pan? Within a few seconds it is too hot to touch, and in a minute—or, at most, two minutes—it is ready for use. By what system could the food be cooked in two minutes? M. Delahaye did not think electricity would be used for cooking. Many gas engineers think the same with regard to electric lighting, and I know at least one who is ready to prove to anybody that electricity cannot be made at a price low enough for the electric light to be largely used. Electric heating, as most up-to-date engineers know, is rapidly spreading, and it will soon be a rarity to find a house where electricity is used at all in which at least some form of electric heating apparatus is not to be found. The use of the larger kinds of apparatus will depend very much upon the action of the supply companies, but there are signs that before long electricity will be cheap enough for use in many ways at present out of the question. One instance will show this. Several applications have been received from bakers who wish their ovens fitted for electric heating, but with current at the present charges the cost of working would be prohibitive. What a field for the supply companies! There are thousands of ovens which would require current from *midnight to early morn*. Probably no other outlet of so promising a nature could be found. To sell current when there is not even a day load available seems to be a move in the right direction.

REVIEWS.

Scientific and Technical Papers of Werner von Siemens. Vols. i. and ii. Translated from the second German edition. London: John Murray, Albemarle Street.

The first of these two volumes appeared in 1892, and contained the scientific papers and addresses of the author; the second volume, which has just appeared, contains technical papers, and a third volume will shortly appear giving an account of the career of Werner von Siemens, and the progress of the celebrated firm of Siemens and Halske.

Few men, in our century, have originated and carried to commercial success, so many valuable applications of science as Werner von Siemens. Consider, for example, what he has done for telegraphy, the dynamo, electric lighting, electric railways, electrometallurgy and electric measurement, in the way of initiation or improvement. His contributions to pure science would suffice to make the reputation of a professional scientist; witness his investigations on the influence of light on the conductivity of selenium, on the theory of magnetism, the luminosity of flame, and meteorology. Siemens belonged to the class of what we might call scientific engineers, whose grasp of principles and knowledge of the latest advances in scientific theory enables them to soar far above the mere imitation of their predecessors.

Siemens's first paper, of the date 1845, describes and discusses the Stirling hot air engine, that beautiful but impracticable heat engine which has proved an *ignis fatuus* to so many young inventors. His views on the theory of this engine are not quite what is now accepted, but the science of thermo-dynamics can hardly be said to have been born at the date when this paper was written. Perhaps the earliest of his important discoveries was the application of gutta-percha as an insulator to electric conductors; he says: "I received the first sample of gutta-percha in the autumn of 1846, just when I was engaged with experiments with underground wires, and at once made use of it for the purpose. It turned out that even the thinnest layer of the material when freed from moisture possessed sufficient insulating property for the above-mentioned purpose." The importance of this discovery can scarcely be exaggerated.

An amusing, and now well known, incident is related by Siemens in connection with a visit to the Cheops pyramid in 1859. While he was at the top of the pyramid a sand storm occurred, and "we noticed a whistling noise which I ascribed to the increasing violence of the wind. The Arabs who were squatting around us on the nearest steps sprang up suddenly with a cry of 'chamsin,' and held up their forefinger in the air. When I held up my own forefinger in the air, there was a slight hardly perceptible pricking observable on the skin of the finger which was opposed to the wind. I could only explain this fact, observed by all of us, as an electrical phenomenon, and such it proved to be. . . . An uncorked bottle was charged by holding it in the hand, especially when the neck was directed towards the wind. When I had completed the outer coating of my bottle by wrapping it in damp paper from our provision basket, the charge was so strong that I could make use of it as a very powerful weapon of defence. After the Arabs had watched our proceedings for a time with wonder, they came to the conclusion that we were engaged in sorcery, and requested us to leave the pyramid. As their remarks, when interpreted to us were without effect, they wanted to use the power of the strongest to remove us from the top by violence. I withdrew to the highest point, and fully charged my strengthened flask, when the Arab leader caught hold of my hand and tried to drag me away from the position I had attained; at this critical moment I approached the top of my flask to within striking distance of the tip of his nose, which might be about 10 mm. The action of the discharge exceeded my utmost expectation. The son of the desert, whose nerves had never before received such a shock, fell on the ground as though struck by lightning, rushed away with a loud howl, and vanished with a great spring from our vicinity followed by the whole of his comrades." This experiment is quoted by Schuster as showing that sandstorms carry up into the air an electric charge from the negatively electrified surface of the earth.

Readers of these interesting volumes will be surprised to learn how many of the inventions which are generally supposed to have originated in this country have been really made in Germany. In an interesting popular address on the electric telegraph, reprinted in the second volume, the first invention of the electric telegraph is ascribed to Dr. Sömmering of Munich who constructed an electro-chemical telegraph a few years after Volta's great discoveries in 1808. Schweigger of Erlangen followed by reducing the 26 wires in Sömmering's telegraph to two. After Oersted's discovery, Fechner of Leipzig invented the needle telegraph, and after Faraday's discovery Gauss and Weber, in Göttingen, replaced the battery by a magneto induction apparatus. The telegraph of Gauss and Weber was the first actually carried out, and served from 1833 to 1844 for the telegraphic connection between the Magnetic and Astronomical Observatory at Göttingen. Steinheil, of Munich, constructed the second working electric telegraph in 1837; he printed his messages on a strip of paper carried onwards by clockwork, he also first used acoustic signals produced by bells of different tones and first employed the earth return. It was only after this stage of development had been reached that "industry takes possession of these notions, and we see a race among all civilised nations to begin practically to develop and realise them. In this fourth or practical period the Anglo-Saxon race first took the lead, which is distinguished by a more practical direction than others." We shall have to be content with that.

Another *vexata questio*, the question of priority of invention of the dynamo-electric machine, is very fully discussed by Siemens in a paper first published in 1882. Werner von Siemens first brought the theory of the dynamo machine before the Berlin Academy of Sciences on January 17th, 1867, after he had already, in the beginning of December, 1866, shown such a machine in action to many members of the Academy. "At my recommendation, and on the basis of my communication, my brother, Dr. C. William Siemens, sent at the end of January a communication on the subject

to the Royal Society in London. About fourteen days later Prof. Wheatstone sent a paper on the same combination to the same society. Both William Siemens and Wheatstone read their communications on the same day, William Siemens having given the prior notice. From this double communication, it was held in England that Wheatstone and I had made and published the discovery simultaneously. This was entirely false, as my first publication through the Berlin Academy was quite a month earlier. About a year later a provisional specification of the Brothers Varley became known, which had previously been kept secret. In this the dynamo-electric principle was, in fact, included. It was not discussed theoretically at all, and the one essential principle—the strengthening of the current by reversing the motion of the machine—was not once mentioned. According to English patent law, this provisional specification gave the Brothers Varley commercial rights. In science, however, the principle introduced by Arago, and adopted by the French Academy, which is generally accepted, holds good, viz., that a right of priority belongs to him who has first communicated a new idea in a clearly comprehensible manner through printing or communication to an academy or society which publishes its proceedings. Even if it is assumed that Varley and Wheatstone discovered the dynamo-electric principle contemporaneously with me, or even earlier than I did or had practically used it, still the priority belongs to me alone, for I first made the publication for the public benefit. If, moreover, Wheatstone's son-in-law, Mr. Sabine, asserts that he had already discovered the principle early in the year 1866, he has not produced any proof of it. If the apparatus brought before the Royal Society in February, 1867, was already made in the previous summer by Mr. A. Stroh, this indeed proves nothing. That which the mechanic made was a magneto-electric exploder with Siemens armature, such as had been made for years. It only became a dynamo-electric machine by its connections. Such data cannot prove claims for priority." Siemens then disposes of the claims of Hjorth and Pacinotti, by the assertion that their inventions were not really dynamo machines, but magneto-machines strengthened by electro-magnetism.

Siemens does not appear to be very generous in the treatment of his rivals. Without expressing any opinion here on the whole case, we think that the principle of Arago on which he rests a great part of his case, is opposed, not only to English patent law, but to common sense. Whoever can prove by indisputable evidence of any kind that he was the first inventor, has the right of priority. Siemens does not deny that a provisional specification, though kept secret for a certain time, is indisputable evidence of what was in the mind of the inventor at the date when he filed it, hence his claim to priority, as far as the Varleys are concerned, must be established on a different basis.

These volumes, apart from the few points our space has allowed us to discuss, are full of interest. The reader will come across the beginnings of a remarkably large number of inventions that are now in full blast, and which have contributed more in half a century to the wealth and civilisation of the world, than centuries of evolution without great inventors such as Werner von Siemens. This book reads like a romance of science, and will give the student a truer conception of electrical problems and their solution than the secondhand descriptions of the best text-books.

A Laboratory Manual of Physics and Applied Electricity, arranged and edited by EDWARD L. NICHOLS, Professor of Physics in Cornell University. Vol. I., *Junior Course in General Physics*, by ERNEST MERRITT and F. J. ROGERS. London and New York: Macmillan & Co.

The most remarkable feature about physical work in educational institutes of the higher class has been the rapid development of laboratory teaching during recent years. The result has been a calling forth of manuals intended for the student's guidance in the laboratory; they have been issued under all kinds of titles, at various prices, and are of very varied grades of merit. No one can really appreciate what deficiencies exist in such text-books unless it has been his lot to form one of a fairly large class at some technical college or other place of instruction, and to be left in the physical laboratory with no better guide than the prescribed text-book to work out the usual problems with an occasional word of advice from an overworked demonstrator. Of the host of titles, three alone stand out from their neighbours as being possessed of some of the merits and few of the deficiencies which go to make or mar the utility of a treatise on experimental physics; these are Glazebrook and Shaw, Kohlrausch, and Stewart and Gee. The first was called into being by the demands of the elementary classes at the Cavendish Laboratory, Cambridge, the second by the needs of the University of Strasburg, and the third for the benefit of those attending Owens College, Manchester. A fourth might be added in the shape of Professor Ayrton's "Practical Electricity" which is the nearest approach to the technical handbook of any. In the German language there is Witz and Wiedemann and Ebert, while larger treatises on experimental physics have been given us by Jamin, Winkelmann, Violle, Wiedemann and Preston. With the growth of experimental work and the extension of laboratory equipment, even these do not satisfy the existing needs—indeed, in many colleges the pocket-book of Munro and Jamieson is used in preference to all others, but then there is the evident lack of manipulative instructions which detracts from its advantages.

Prof. Nichols has therefore undertaken to supply, in some measure, the needs of a modern laboratory, in which he himself believes the existing manuals of physics have been found inadequate. The book before us is the first volume of two which cover the routine course of a physics student at Cornell, and may, therefore, be taken as an indication of the training afforded by that Institute. The experiments are those for which provision exists in the laboratories controlled by the editor, while the book is divided into sections, each of these being written by the assistant professor in charge of the special department of which the section treats. The scope is intentionally limited in theory, although we fail to recognise that the limitations have had any effect in practice, thus it is stated that no attempt has been made to provide a complete and sufficient source of information for laboratory students; on the contrary, it has been thought wise to encourage continual reference to other works and to original sources. This is true of the advanced sections, but not altogether so of the junior portion, as a matter of fact; while it might well be questioned if a junior student would gain by such a course, as he would probably be unable to comprehend the details of an original investigation, even if the memoir were put before him as a guide. The three classes of students who may expect to profit by this compendium of all that is best at Cornell, are beginners or freshmen, *i.e.*, matriculated university students with the usual school training in the principles of physics, second year technical students, and those who take a post-graduate course, or defer taking their diploma or degree until they have had time to attempt some original work. There are thus three parts, one in the first volume, and two in the second, but taken together they form a progressive course, at the end of which a careful student should be fitted to take up any physical investigation, and in carrying it out to rely solely upon his experience and on original memoirs or papers in the transactions of learned societies.

The English reader will find little difference between the course as in vogue at Cornell and that through which one would have to pass at a home university. The freaks of language strike one on perusal of the pages of Volume I., for example, *practicant* is met with in the preface, and also later, we should write this "practician," and even then would be liable to be accused of a liking for the barbarities of language. "Experimentation" may be forgiven, but why should "platting" be systematically used instead of plotting? The method of laying off a curve on squared paper is usually termed plotting, the verb "to plot" used in this sense having come to us from its use in surveying where, as everyone knows, the common saying is "to plot a survey."

The introduction gives the objects of the experiments afterwards described as illustrating the principles and laws that have previously been taught by text-books or lectures, and to familiarise the student with proper methods of observation and means of conducting experiments. It is assumed that the student possesses some knowledge of analytical geometry and of the calculus, also that he has completed a text-book and lecture course in the principles of physics. The first few pages give very useful information on the

recording of results, the methods of making observations, units, and the matter which should appear in a report. A detail in this section is evidently the general discussion of errors and their elimination. We find here also a very clear but condensed account of the method of least squares. The book is divided up into chapters, and these again into groups, the division being useful in the laboratory to indicate the apparatus required and class of work. Length, time, and class are taken up in group A, and the spherometer and cathetometer dealt with; we miss the dissertation on side and end measurement of length so often met with, but cannot say we regret the omission. Instead of this we have the calibration of a thermometer tube, a much more useful exercise. Statics, friction, and simple machines, uniformly accelerated motion, moments of inertia and simple harmonic motion and elasticity are also taken up in Chapter I., while in Chapter II., density and properties of gases are considered. Next comes the important subject of calorimetry, and we are glad to see this given adequate treatment. The determination of water equivalent and radiation being especially clear.

Chapter IV. is on static electricity, naturally not a promising subject, but the most is made of it. The condenser and Holtz machine are the subjects of investigation, the latter being treated more fully than is the custom. Something might, however, have been done, we imagine, with the Wimshurst machine as a variation on the main theme. The next chapter is on magnetism. Lines of force and magnetic moments are set before the reader, but even here the writers have something new to say, thus it is pointed out that in the neighbourhood of every magnet or system of magnets there are in general two or more points where the magnetic field due to them exactly neutralises the earth's field. At these points there will be no directive force acting on the searching compass needle, and on opposite sides of these points the needle will point in opposite directions. The student is required to locate these points on a diagram. The electric current is introduced by some general statements setting forth the positive direction and the value of the unit current as defined in the bulletin of the U.S. Geodetic Survey and the resolutions of the Chicago Congress. Immediately afterwards the tangent galvanometer is discussed, $10\ H/G$ in $C = 10\ H \tan \delta/G$ is called the reduction factor or working constant. The constant is therefore the current that will produce unit deflection, or a deflection of 45°, and this is in accordance with the practice of the best English writers, although we have seen recently several statements making it 1° on the scale. Assuming that mirror instruments obey the tangent law we find a useful reference to the shape in which the scale should be bent to give direct readings proportional to the current; a reference might have been given here to Mr. Trotter's paper on the subject. The general law of the tangent galvanometer is then proved experimentally, the Ryan form of voltameter is described, and its use illustrated in the measurement of the constant of a sensitive galvanometer whose constant is not directly calculable. On page 173 we find a description of what is practically the wonderful (?) Macdonald form of Daniell cell, it is here used to give a fairly constant and uniform E.M.F. of 1·074 volts. The theory of shunts is afterwards treated in the manner first given by Prof. Ayrton, and the Vienna method of measuring current is shown to be based upon it. The chapter on the measurement of resistance takes up the Wheatstone bridge and fall of potential methods, specific resistance and temperature coefficients, the internal resistance of batteries, and the resistance of electrolytes. It is by no means complete, but those who have gone through it will be quite fitted to proceed to special treatises. Electrical quantity is considered in the next few pages, and naturally the ballistic galvanometer occupies a prominent place. Its uses in connection with capacity tests are dealt with, but surely the use of shunts with the ballistic galvanometer is a matter that might receive more attention at this stage than is given to it. After a fairly satisfactory section on electro-magnetic induction the subject of sound is gone into, followed by mirrors and lenses, and the spectroscope and photometer. In this, the first volume, the electrical portion presents less novelty in treatment than do those others mentioned, but what there is merits every approval. The illustrations and style are so good that it is a work which one regards favourably on first inspection; this feeling is intensified on becoming better acquainted with the contents.

CALORIMETER TESTS.

The tub and weighing machine has usually been looked upon as an accurate method of determining the dryness of steam or its percentage of moisture, but of late years it has gone into disfavour, perhaps, because its appearance savours too much of crudeness to suit technically educated men who must have something of brass and glass to work with and cannot be expected to put up with anything so vulgar as an old tub.

Hence the rise and progress of the salt test, which is, we believe, of German origin, and was therefore looked upon as scientific and accurate and proper to be adopted. However, even its best friends have ceased to rely upon the salt test, and for our part we really cannot see how it was that this test was relied on, for it does not appear to us that there is even a prospect of certainty in the entrainment with steam leaving a boiler of anything approaching the correct salinity of the bulk of the water in such boiler. However, there are wheels within wheels even in steam tests, and the salt test served to turn one wheel of a series very probably.

If we are to accept the paper of Prof. Jacobus, some time ago presented to the American Society of Mechanical Engineers, wherein are given the results of some tests of Professor Denton, we must first doubt the accuracy of the steam collected by the steam pipe leading to the calorimeter, whatever be the type of calorimeter employed. These tests showed that a nozzle closed at the end and projecting horizontally into a steam pipe of 3 inches diameter, the nozzle being a piece of ½-inch pipe with six $\frac{7}{32}$nds holes drilled in it, indicated 6·3 per cent. of moisture, whereas the true quantity was 2·3: 14·6 in place of 8·8 and 17·8 in place of 10·1 A vertical nozzle with twelve similar holes showed 5·5 per cent. instead of 2·5 per cent., 11·1 instead of 4·7, and 20·9 instead of 10·9. In a special nozzle with a slot opening 1 inch × ¼ inch, it is curious to note that when the slot faced the current of steam it underrated the moisture present, but when turned away it overrated it, from which the conclusion is drawn that water striking on the nozzle body clung to it and crept round it until it entered the slot with the steam. Any form of nozzle has probably but a poor chance of collecting a true sample. We do not know what is the relative quality of the steam at top, bottom, sides, or centre of a steam pipe, and if we did know this, and so were able to allot a number of nozzles at various points in the cross-section of a steam pipe, we do not know the relative velocities of the steam at such points in the cross-section of the pipe, and this would prevent a correct proportion in size and number of the nozzles at the various *loci*.

The calorimeter employed was that of Barrus, which acts on the throttling principle, and the true amount of water present was obtained by actually injecting water into the steam pipe at about 65° F. This water travelled 8 feet in this 3 inch steam pipe into a separator and thence into a steam drum, to which it was admitted throttled, so as to preserve atmospheric pressure in the drum, whence it was led to a surface condenser and finally weighed.

The calorimeter was placed between the throttle and the separator, and as the drip of the separator was closed, no water was really separated out; the separator acted as a mixer. Necessarily the steam with which the water was injected contained no previous moisture; it was superheated, but this is not as clearly stated as it should be. Knowing, then, its temperature and that of the injected water, the final weighing shows the amount of water present after due allowance is made for the effect of the superheat.

The results simply show that calorimeter tests are all unreliable, and that granting the goodness of the Barrus calorimeter, it is entirely negatived unless we can determine upon some accurate means of collecting samples to be tested.

It would appear that roughly with the perforated nozzles the true percentages of moisture are from ⅓ to ⅔ the amount shown by the calorimeter, the average of all the reliable tests given being $\frac{14}{25}$. The narrow slot, above named, showed nearly six times too much when pointed from the current, seven times too little when facing it, and just about double when at right angles. This slot was placed horizontally at the middle at the centre of a 3 inch pipe, and was itself 1 inch × ¼. If the tests have any value, it would appear that a similarly proportioned slot placed likewise in other steam pipes, would, perhaps, give results of equal inaccuracy, viz, double the correct coefficient of wetness. If so, such a slot might safely be employed until something better was forthcoming. What is wanted is not an accurate collector, but, like a ship's chronometer, one that will have a uniform rate of inaccuracy, and that known. Seeing that the general tendency is to collect samples worse than the reality, steam engines in all or many past tests have been given more credit than they have been entitled to demand on the score of steam quality supplied to them As regards the salt test, it would be interesting to have a few salinometer tests of water drawn from the very surface of the water in a boiler, and of that drawn from other horizons.

The whole system of calorimetry is in an unsatisfactory condition. Why does a boiler give wet steam when an engine is to be tested, and why does it give dry steam when a boiler or a fuel is to be tested? We confess to having very little faith in a large percentage of tests which appear with so great a flourish. W. B.

NEW PATENTS—1895.

12,651. "Improvements in electrolytical apparatus." R. Heathfield and W. S. Rawson. Dated July 1st.

12,683. "Improvements in or relating to telephone transmitters." T. Berdell. Dated July 1st.

12,690. "Improved means for regulating the speed of electrically-propelled vehicles." C. Brault and C. Jeantaud. Dated July 1st.

12,697. "An automatic electric fire alarum and indicator of heavy air in a room or other enclosed space." A. HANSEN and H. H. FRIMAND. Dated July 1st.

12,711. "Improvements in or connected with the insulation of copper conductors for electric light wires, cables, telephones, all electrical work, and other purposes." J. A. LONDON and H. P. BAILEY. Dated July 2nd.

12,717. "An instrument for acquiring the art of telegraphy." J. COCKING. Dated July 2nd.

12,719. "An improved filament for incandescent electric lamps." J. ESTRADE. Dated July 2nd.

12,772. "Improvements in automatic safety devices for electric circuits." L. G ROWAND. Dated July 2nd. (*Complete.*)

12,773. "Improvements in or relating to the generation of electricity and the mode of operating steam dynamos and the like, and in apparatus therefor." J. A. KINGDON. Dated July 2nd.

12,836. "Improvements in automatic electric cut-outs." C. M. DORMAN and R. A. SMITH. Dated July 3rd. (*Complete.*)

12,869. "Improvements in or relating to automatic electric time calls." J. L. Jack, jun. Dated July 3rd.

12,871. "Improvements in electrical circuit closers." C. A. MCEVOY. Dated July 3rd.

12,888. "Improvements in electric arc-lamps." H. H. LAKE. (Communicated by J. Einstein and S. Kornprobst, Italy.) Dated July 3rd.

12,893. "Improvements in signal apparatus in combination with tumblers, switches, and switch boxes." F. B. STANTON. Dated July 3rd.

12,953. "Manufacture of chloride of lead." THE CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED, and J. G. A. RHODIN. Dated July 4th. (*Complete.*)

12,954. "An improvement in secondary voltaic batteries." THE CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED, and G. A. GRINDLE. Dated July 4th. (*Complete.*)

12,962. "Improvements in electric lighting for vehicles." J. A. AGERON. Dated July 4th.

13,014. "Improvements in dynamos and electric motors, the invention being particularly applicable to motors carried in the rudders of vessels." A. G. NEW and A. J. MAYNE. Dated July 5th.

13,090. "Improvements in electrolytic cells." S. Z. DE FERRANTI. Dated July 6th.

13,091. "Improvements in electric switches." S. Z. DE FERRANTI. Dated July 6th.

13,113 "Improvements in telephonic installations." H. H. LAKE. (Communicated by E. Baivy, Belgium.) Dated July 6th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

19,924. "Improvements in the combination of electric light with metallic bedsteads." J. W. HOYLAND and W. H. STURGE. Dated October 19th. In the construction of the metallic bedsteads, the inventors provide means and accommodation to receive an electric lamp which is contained in a suitable fitting carried in or upon a gimbal or other similar universal like joint, by which the rays of the light may be easily thrown into any desired direction by the occupant of the bed, such as for reading, &c., purposes, or be thrown upon any special object in the room, such as a clock, &c. 1 claim.

20,330. "An improved electro-magnetic motor in which dead points are obviated." I. VAGO. Dated October 24th. This invention relates to an electro-magnetic motor or machine working with direct or alternating currents. 4 claims.

21,323. "Improvements in apparatus for welding electrically." W. P. THOMPSON. (A communication by C. L. Coffin, of Detroit.) Dated November 6th. Consists in an improved machine for welding flanges electrically. 9 claims.

21,353. "Improvements in the application of electric and other motors to railway vehicles." H. S. PARK. Dated November 6th. The object of the invention is to make a simple, economical and efficient motor to be used in connection with electric energy on railway cars. 13 claims.

21,629. "Improvements in and relating to electric railways." L. HANISCH and the HOERDER BERGWERKS & HUTTEN-VEREIN. Dated November 9th. Comprises a channel constructed of sheet-metal and designed for the reception of a feed conductor, this channel being deepened and widened for collecting and leading away the water or the like which may pass into the same through the longitudinal slot provided at its top for the communication between the car and the conductor. 7 claims.

21,731. "Improvements in arc lamps." C. A. DAY. (A communication from abroad by G. J. Schoeffel, of Brooklyn.) Dated November 10th. The main objects of the invention are to provide a lamp with improved feeding devices for the carbons; to provide such a lamp, and means for supporting it, that there shall be a minimum of interference with the projection of the light by the search light reflector, when the lamp is used for search light purposes. 10 claims.

22,486. "A sheet, card, or book, with alphabetical spaces or divisions containing names, numbers of telephones, and addresses of clients, or customers, for telephone renters' use." S. BUCKTHOUGHT. Dated November 21st. The object of the invention is to avoid the necessity of searching through telephone subscribers' names other than those who are clients or customers of the person or firm carrying on a business, when said person or firm is requiring to communicate by telephone. 2 claims.

23,970. "Improved supports for overhead conductors on electric railways and tramways." A. ANDERSON and J. M. ANDERSON. Dated December 10th. In accordance with this invention, the trolley wire support is provided with a groove, way, or channel, having upright walls, between which are pivotally supported movable cams or locking dogs, constructed so as to be operated by tension or longitudinal strain or movement of the trolley wire, to firmly retain the said wire in its groove or channel. 9 claims.

24,234. "Reflectors for electric lighting." P. KORBER. Dated December 13th. Claim:—A reflector for electric lighting characterised by the use of silvered mirror or like coating or covering on a portion of the surface of the globe of an arc lamp, or of a shade over the globe of an incandescent lamp for the purpose of causing the light rays to be reflected in a certain direction only.

24,374. "Improvements in the insulation of electric wires or cables." F. CLOUTH. Dated December 14th. Claim:—The combination with an electrical conducting wire or conductor of a covering layer of caoutchouc surrounding said conductor or wire, and a layer of gutta-percha surrounding and enclosing the caoutchouc, substantially as and for the purpose set forth.

24,431. "An improvement in tubular posts for telegraphic and other purposes." SIEMENS BROS. & Co., LTD, and G. W. PERRY. Dated December 15th. Claim:—A tubular post for telegraphic and other purposes, consisting of a lower taper part adapted to be driven into the ground, and an upper part which is introduced into the lower part and clamped therein by screwed split rings, substantially as described.

24,564. "Improvements in and connected with electro-locomotives." W. E. HEYS. (Communicated from abroad by J. J. Heilmann, of Paris.) Dated December 18th. Relates to that system of electro-locomotion on railways and tramways in which the electromotors directly drive the axles of the vehicles. Its object is to prevent the shocks and vibrations to which the axles may be subjected being transmitted to the motors, and at the same time to provide for an elastic connection between the armature of the motor and the axle which it drives. 2 claims.

24,569. "Method of and apparatus for producing locally annealed steel and other metal plates." W. FAIRWEATHER. (Communicated from abroad by the Thomson Electric Welding Company, of America.) Dated December 18th. Consists essentially in hardening the whole piece of steel or other metal, then locally heating the spot or portion in the body thereof to be softened to the proper temperature by an electric current passed through the metal itself, and then allowing the said portion to cool while keeping it supplied with a gradually diminishing amount of heat from such current, the rate of diminution being adjusted, as hereinafter described, to the tendency of the surrounding mass of metal to carry the heat away, so as to cause it to cool gradually, and at a sufficiently slow or proper rate to become soft at such heated portion. 5 claims.

24,573. "Improvements in or connected with the working of the points or switches of tramway and railway lines." J. W. LITTLEJOHN. Dated December 18th. The inventor provides the free end of the pivoted point or switch with projecting arms and inclined plane portions, either of which may be actuated when desired by the driver, through the medium of suitable arrangements of levers and wheels, which may be actuated by foot or otherwise; one of said arrangements being mounted at each end of the car or other vehicle. 3 claims.

24,630. "Process of and apparatus for dissociating soluble salts by electrolysis." H. S. BLACKMORE. Dated December 18th. Consists in employing a body or bodies of liquid electrolyte or solution of salt to be dissociated, and independent bodies of other liquid; in separating the bodies of electrolyte from the independent bodies of liquid through the agency of a liquid conductive medium of greater density than either of said bodies, and by means of walls or partitions between the electrolyte and the independent bodies which extend below the surface of said heavy liquid or conveyer of ions; in exposing the liquid electrolyte and the independent bodies of liquid to the action of an electric current through suspended electrodes; and supplying and withdrawing the electrolyte and independent liquid bodies with the absorbed or combined ions, without stopping the operation. 16 claims.

25,076. "Improvements in or relating to telegraphic transmitters, and recording apparatus therefor." A. J. BOULT. (A communication from C. Spiro, of New York.) Dated December 24th. Has for its principal objects to enable messages to be sent with greater speed, ease, and accuracy than has hitherto been possible with the usual device, and, moreover, when used in combination with recording apparatus, to ensure at the same time as the telegraph message is being sent a faithful record of said message being automatically made. 12 claims.

25,080. "Improvements in or relating to the separation of metals by electric action." T. T. OLIVER. Dated December 24th. The primary object of the improvement is to provide an apparatus for extracting metal from a mass of metal-bearing material introduced into it in molten condition, by charging the molten mass with a positive current of electricity, and passing it over a body presenting a solid metal surface negatively charged with electricity, whereby the metal contained in the molten mass shall be deposited on, and adhere to, and thus be intercepted by the negatively charged surface; and the slag will tail off. 9 claims.